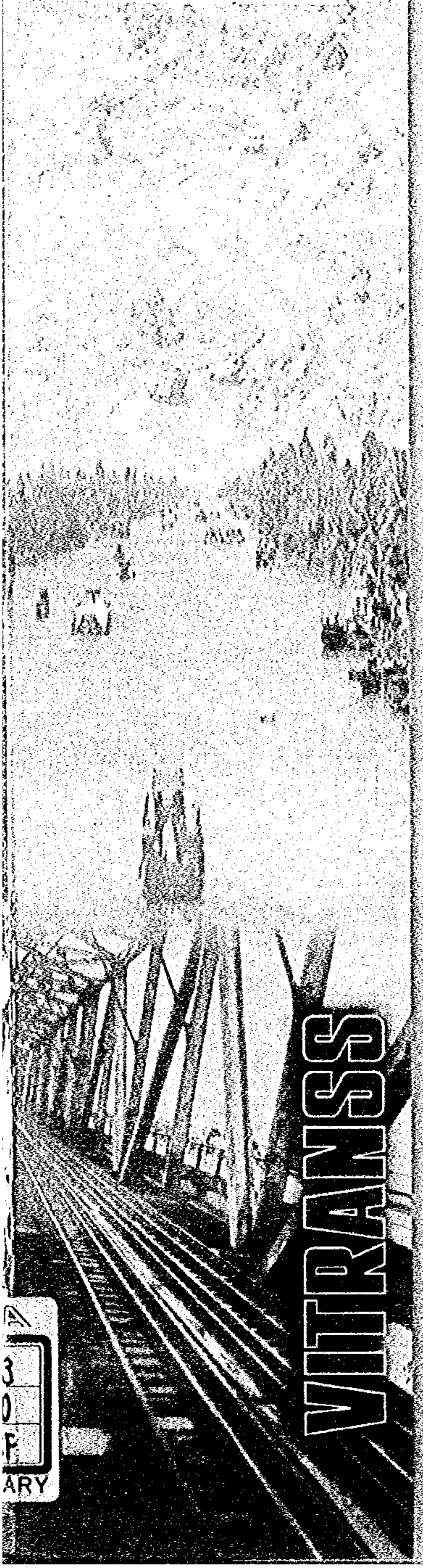
社会開発調査部報告書



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF TRANSPORT, SOCIALIST REPUBLIC OF VIETNAM (MOT)
TRANSPORT DEVELOPMENT AND STRATEGY INSTITUTE (TDSI)

No.

THE STUDY ON THE NATIONAL TRANSPORT DEVELOPMENT STRATEGY IN THE SOCIALIST REPUBLIC OF VIETNAM (VITRANSS)

APPENDIX TO TECHNICAL REPORT NO.1

JICA STRADA TRAINIG MATERIAL

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July 2000

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Japan International Cooperation Agency (JICA)
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PREFACE

During the period of the Study on the National Transport Development Strategy in Vietnam (VITRANSS), various technical papers have been prepared by different Study Team members in various occasions to facilitate the discussions with counterpart team, concerning subsector agencies and to document major findings and outputs produced in the process of the Study. These papers have been organized into a series of technical reports (See Table A below) which intend to provide more detailed background information for descriptions and discussions made on key study components and issues. These technical reports are working documents of the Study which, however, will be useful for further reference, by the counterpart team and related subsector agencies.

Table A
List of Technical Reports

No. 1	Transport Surveys and Database
No. 2	Main Commodities Analysis and Freight Transport
No. 3	Transport Cost and Pricing in Vietnam
No. 4	Transport Sector Institutions
No. 5	Road and Road Transport
No. 6	Railway
No. 7	Inland Waterway
No. 8	Port and Shipping
No. 9	Air Transport
No. 10	Rural Transport and Cross Border Transport
No. 11	Environment
No. 12	Transport Sector Funding

Appendix to Technical Report No.1
JICA STRADA TRAINING MATERIAL

Table of Contents

GLOSSARY

CMA	Cost Minimization Assignment
GDP	Gross Domestic Product
GRDP	Gross Region Domestic Product
HCMC	Ho Chi Minh City
IRI	International Roughness Index
JICA	Japan International Cooperation Agency
JICA	Japan International Cooperation Agency
MOC	Ministry of Construction
NCPFP	National Committee for Population and Family Planning
NTSR	National Transport Sector Review
OD	Origin-Destination
PCU	Passenger Car Unit
SUE	Stochastic User Equilibrium
TPM	Trend Pattern Method
TDSI	Transport Development and Strategy Institute
VITRANSS	Vietnam National Transport Development Strategy Study
VND	Vietnamese Dong
VR	Vietnam Railways
WB	World Bank

1 INTRODUCTION

1.1 About User's Operation Manual

Following the National Transport Sector Review (NTSR, 1990-1992), a scientific and comprehensive transport master plan study, the Study on the National Transport Development Strategy in the Socialist Republic of Vietnam (VITRANSS, 1999-2000), has been undertaken, which gave motivation to develop the VITRANSS demand forecast model (which is hereinafter referred to the VITRANSS model) not only to forecast transport demand of both passenger and freight but also to evaluate projects which includes not only ones proposed by VITRANSS study team but on-going projects. With the development of the VITRANSS model, technical transfer has been taken at the same time through learning sessions, seminars, intensive training and sub-sector workshops in order to learn planning process and methodology to enable for counterparts to update the plan by themselves, to strength the ownership of the plan and to promote the consensus toward the policy formulation. These kinds of efforts have worked effective and useful. But the technical transfer so far rather concentrated on the concept of the VITRANSS model so that another efforts, focusing intensively on the operation facet of the VITRANSS model, were needed to operate, manage and maneuver it. With the official request of the Transport Development and Strategy Institute (TDSI), another efforts of the technical transfer with a focus on the operation point have been implemented and a user's operation manual has been also prepared. This is the user's operation manual of the VITRANSS model drawn up from materials handed out in the training course, which makes it possible to operate or manage the VITRANSS model.

1.2 Focusing Points

The VITRANSS model was to be operated with the following goals:

i) To simplify;
ii) To Make clear; and
iii) To handle easily

To Simplify

The VITRANSS model consists of a lot of procedures, components and tasks and it is thus needed to make it simplify as much as possible. To simplify, terms of sub-model and operator are adopted, i.e., the VITRANSS model is separated into six sub-models and each sub-model includes several operators. This kind of classification makes it effective and useful to understand or grasp the structure of the VITRANSS model.

To Make Clear

Basic idea, technical or academic background and task skill are among the VITRANSS model. To make it clear, sub-models or components strongly related to those contexts need to include additional explanations of theoretical background, methodologies and actions taken and, if necessary, detail meaning of equations or parameters used in the model. Efforts were given to get rid of "black box" and help understand its basic concept and idea clearly through this text.

To Handle Easily

Handling easily is one of most important factors which enables for counterparts to manage the VITRANSS model and apply to the plan. For this reason, complicated troublesome steps were integrated or combined into only several steps so that results to be required could be calculated with simple operation.

1.3 Training Schedule

Training course was scheduled as Table 1.1.

Table 1.1
Training Schedule of VITRANSS Demand Forecast Model

Step	Date	Contents
Step 1	Sep. 8	Overall Structure of VITRANSS Demand Forecast Model
Step 2	Sep. 12 & 14	Socio-economic Forecast Sub-model
Step 3	Sep. 19 & 21	Network Building Sub-model 1
Step 4	Sep. 26 & 28	Network Building Sub-model 2
WS1	Oct. 4	Mini Workshop on Network Building
Step 5	Oct. 3 & 5	Formulation of Present OD Matrix 1
Step 6	Oct. 10 & 12	Formulation of Present OD Matrix 2
Step 7	Oct. 17 & 19	Passenger Demand Forecast Sub-model 1
WS2	Oct. 24 & 26	Passenger Demand Forecast Sub-model 2
Step 8	Nov. 6	Mini Workshop on Passenger Demand Forecast
Step 9	Nov. 7 & 9	Production & Consumption Sub-model
Step 10	Nov. 14 & 16	Freight Demand Forecast Sub-model 1
Step 11	Nov. 21 & 23	Freight Demand Forecast Sub-model 2
WS3	Nov. 28 & Dec. 1	Freight Demand Forecast Sub-model 3
Step 12	Dec. 4	Mini Workshop on Freight Demand Forecast
Step 13	Dec. 5 & 7	Project Evaluation Sub-model 1
Step 14	Dec. 12 & 14	Project Evaluation Sub-model 2
WS4	Dec. 20	Workshop on the VITRANSS Model

Note: All the workshops are prepared and presented by counterpart.

2 OVERALL STRUCTURE OF VITRANSS DEMAND FORECAST MODEL

The VITRANSS model is composed of six sub-models as follows:
i) Macro economic sub-model;
ii) Production/consumption sub-model;
iii) Network building sub-model;
iv) Passenger demand forecast sub-model;
v) Freight demand forecast sub-model; and
vi) Project evaluation sub-model

Besides, present OD matrix formulation was herein taken as one of sub-models and its basic concept and operation are introduced.

Macro Economic Sub-model (Chapter 3)

This sub-model is to forecast socio-economic indicators such as population and GRDP which become important exogenous variables in other sub-models. Population and urban population were forecast after reviewing the two government documents issued by the National Committee for Population and Family Planning (NCPFP) and the Ministry of Construction. On the other hand, the Klein-Kosobud model was adopted to forecast GRDP by sector in the future and its regional and provincial breakdown was undertaken with consideration of present labor productivity (GDP/labor force). This sub-model includes the following operator:

- Socio-economic forecasting operator

Network Building Sub-model (Chapter 4)

This sub-model is to make assignment network and flow-cost (QC) curves. In general, building and checking network are labor-intensive and time-consuming. But, this sub-model applied GIS software of "Mapinfo" so that the network can be easily updated and checked for errors by visual inspections on the screen. Executing this sub-model enables to make not only passenger and freight networks but also QC curves for traffic assignment. This sub-model includes the following operator:

- Network building operator

Present OD Matrix Formulation Sub-model (Chapter 5)

This sub-model is to formulate present OD matrix, making full use of traffic survey data and information provided by relevant agencies. As a result of this sub-model, one can expect matrices by mode and by commodity item that were converted into linked trips. This sub-model includes the following operators:

Passenger Demand Forecast Sub-model (Chapter 6)

This sub-model is to forecast trip generation and attraction, trip distribution, modal split and traffic assignment in terms of passenger transport through conventional four-step demand forecast model. This sub-model includes the following operators:

- Passenger OD matrix generating operator;
- Passenger traffic assignment operator; and
- Passenger preloading operator

Production/Consumption Sub-model (Chapter 7)

This sub-model is to forecast freight volume by commodity item that is produced or consumed in a specific province. Socio-economic indicators, agriculture & industry development policy and trade policy were used as exogenous variables for its forecast. This sub-model includes the following operator:

- Production and consumption forecasting operator

Freight Demand Forecast Sub-model (Chapter 8)

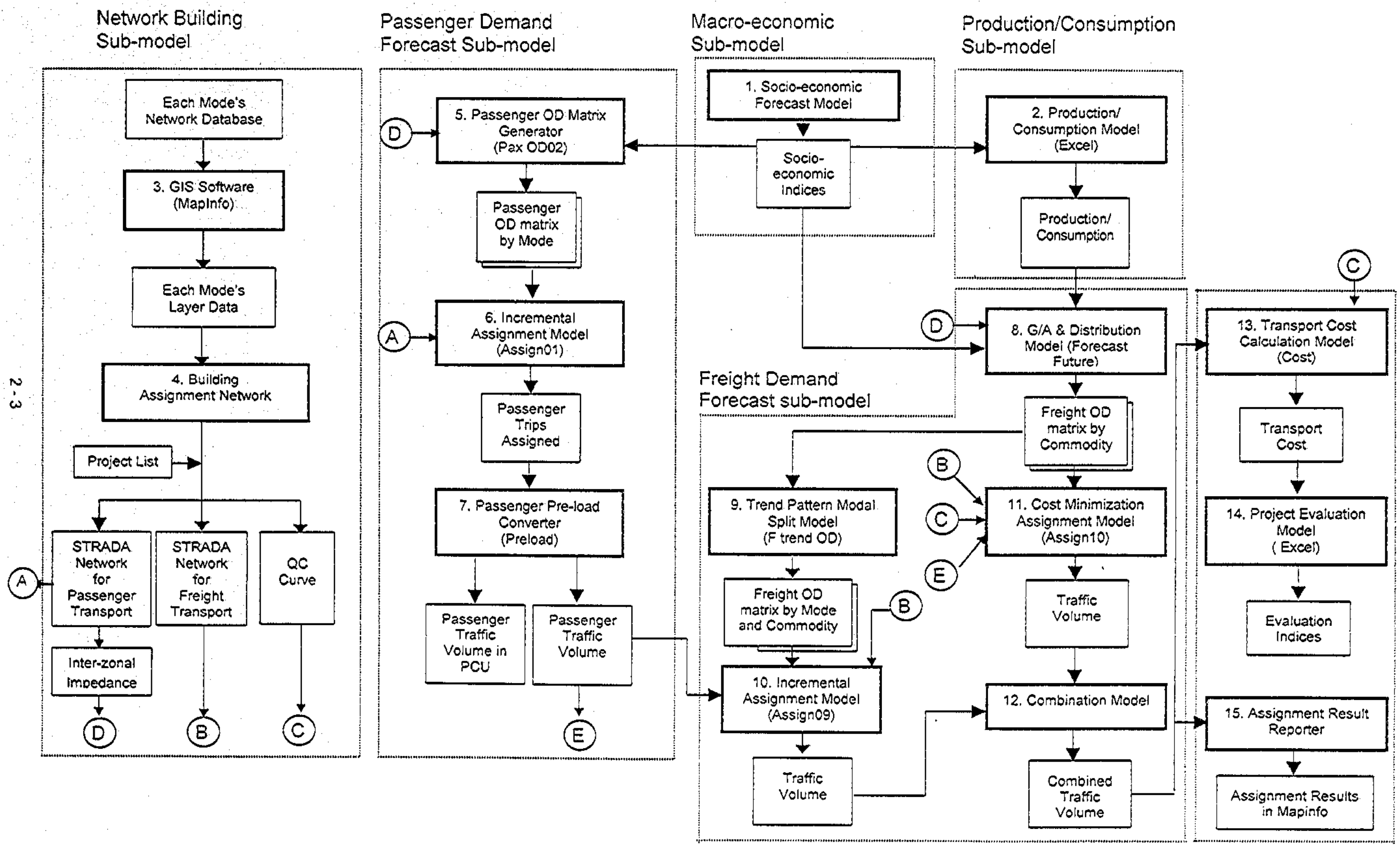
Like passenger demand forecast sub-model, this sub-model is to forecast trip generation and attraction, trip distribution, modal split and traffic assignment in terms of freight transport. One of key characteristics of freight demand forecast is to incorporate two approaches: trend pattern approach (TPA) and cost optimizing approach (COA). This sub-model includes the following operators:

- Freight OD matrix generating operator;
- TPA freight modal split operator;
- TPA freight traffic assignment operator;
- COA freight traffic assignment operator; and
- TPA/COA combining operator

Project Evaluation Sub-model (Chapter 9)

This sub-model is to evaluate projects proposed by the VITRANSS using information on benefit obtained from traffic assignment and project cost calculated. Besides, this sub-model is of function to visualize results assigned using a kind of GIS software of to evaluate them. This sub-model includes the following operators:

- Transport cost calculating operator;
- Project evaluating operator; and
- Traffic assignment representing operator


Network Building Sub-model
Each Mode's Network Database
3. GIS Software (MapInfo)
Each Mode's Layer Data
4. Building Assignment Network
Project List
STRADA Network for Passenger Transport
STRADA Network for Freight Transport
QC Curve
Inter-zonal Impedance
A
B
C
D
Passenger Demand Forecast Sub-model
5. Passenger OD Matrix Generator (Pax OD02)
Passenger OD matrix by Mode
6. Incremental Assignment Model (Assign01)
Passenger Trips Assigned
7. Passenger Pre-load Converter (Preload)
Passenger Traffic Volume in PCU
Passenger Traffic Volume
E
Macro-economic Sub-model
1. Socio-economic Forecast Model
Socio-economic Indices
Production/Consumption Sub-model
2. Production/ Consumption Model (Excel)
Production/ Consumption
Freight Demand Forecast sub-model
8. G/A & Distribution Model (Forecast Future)
Freight OD matrix by Commodity
9. Trend Pattern Modal Split Model (F trend OD)
Freight OD matrix by Mode and Commodity
10. Incremental Assignment Model (Assign09)
Traffic Volume
11. Cost Minimization Assignment Model (Assign10)
Traffic Volume
12. Combination Model
Combined Traffic Volume
13. Transport Cost Calculation Model (Cost)
Transport Cost
14. Project Evaluation Model (Excel)
Evaluation Indices
15. Assignment Result Reporter
Assignment Results in MapInfo

3 MACRO ECONOMIC SUB-MODEL

3.1 Population

Population and urban population were forecast after reviewing the two government documents issued by the National Committee for Population and Family Planning (NCPFP) and the Ministry of Construction. The results estimated were kept as Excel file (population.xls) with the following information.

Microsoft Excel - population.xls

G23 = 906.8

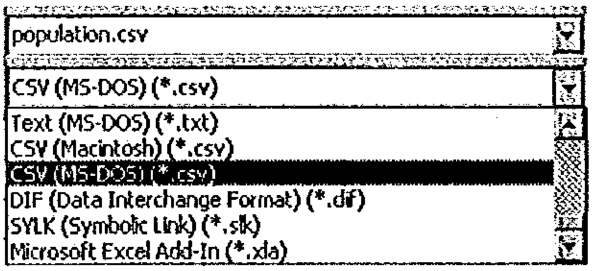
	A	B	C	D	E	F	G	H
1	Zone No.	Province Name	Pop(1999)	Urban Pop(1999)	Pop(2010)	Urban Pop(2010)	Pop(2020)	Urban Pop(2020)
2	1	Hanoi	2672	1539	2989	2182	3590	3340
3	2	Haiphong	1673	568	1934	1044	2200	1551
4	3	Hai Duong	1660	228	2036	245	2275	338
5	4	Hung Yen	1069	93	1300	126	1453	175
6	5	Thai Binh	1786	103	2145	149	2383	178
7	6	Nam Dinh	1888	234	2291	333	2571	395
8	7	Ninh Binh	884	113	1103	168	1249	296
9	8	Ha Nam	792	48	988	162	1070	243
10	9	Ha Tay	2387	191	2863	499	3233	779
11	10	Cao Bang	491	54	665	107	740	156
12	11	Lang Son	705	132	815	145	872	206
13	12	Quang Ninh	1004	443	1456	974	1845	1357
14	13	Thai Nguyen	1046	219	1104	392	1184	601
15	14	Bac Can	275	40	379	97	420	113
16	15	Bac Ninh	941	68	1131	116	1270	190
17	16	Bac Giang	1492	111	1650	125	1806	189
18	17	Phu Tho	1262	179	1715	252	1999	377
19	18	Vinh Phuc	1092	111	1311	94	1487	142
20	19	Lao Cai	595	102	738	137	843	212
21	20	Yen Bai	680	133	956	180	1128	215
22	21	Tuyen Quang	675	72	938	118	1114	171
23	22	Ha Giang	603	51	760	82	906	134
24	23	Son La	881	113	1038	162	1187	199

Table 3.1
VITRANSS Population Data

Year	Data Name	Data Coding
	Zone No.	Zone No.
	Province Name	Province Name
1999	Population	Population by Province (thou. pers.)
	Urban Population	Urban Population by Province (thou. pers.)
2010	Population	Population by Province (thou. pers.)
	Urban Population	Urban Population by Province (thou. pers.)
2020	Population	Population by Province (thou. pers.)
	Urban Population	Urban Population by Province (thou. pers.)

Note: To make use of above information on population and urban population as exogenous variable in other sub-models, one should transform excel file (*.xls) into csv file (*.csv). To do this:

1. Click "file".
2. Click "Save As".
3. Find "CSV (MS-DOS).csv".



4. Input new file name and save.

3.2 GRDP

To forecast GRDP in the future, the econometric model entitled as "Klein-Kosobud" model was applied to the VITRANSS model.

Theoretical Background

Basic formulate are as follows:

$$\frac{S(t)}{Y(t)} = f\frac{Y(t)}{P(t)} \quad (3.1)$$

$$\frac{Y(t)}{N_h(t)} = g\frac{K(t-1)}{N(t)} \quad (3.2)$$

$$\Delta K(t) = h[I(t)] \quad (3.3)$$

$$K(t) = K(t-1) + \Delta K(t) \quad (3.4)$$

$$S(t) = I(t) \quad (3.5)$$

$$N(t) = \delta(t)P(t) \quad (3.6)$$

$$N_h(t) = W_h(t)L_d(t)N(t) \quad (3.7)$$

where,

Y: GDP
S: gross saving
K: capital stock
ΔK: increase in capital
I: gross investment
N: total employment
N_h: annual working hours
δ: employment parameter
P: total population,
W_h: average daily working hours a day
L_d: annual average working days per person

External variables are P, W_h and L_d and the rest are for internal variables. Formula (3.1) shows that gross saving ratio is influenced by the change of GDP per capita. Formula (3.2) is the most important one in this model, stating that labor productivity is determined by capital-equipment ratio. Here, one year is assumed as the gestation period of capital. Formula (3.3) presents the relationship between increment in capital stock and gross investment, which includes investment for replacement and rehabilitation. Formulae (3.4) to (3.7) are easily deduced by the definition of variables or the definition itself.

Parameter Estimate

Formula (3.1) was assumed to have the following logistic curve form:

$$Y = \gamma / (1 + \exp(\alpha X + \beta)) \qquad (3.8)$$

where,

Y: S(t)/Y(t)
X: Y(t)/P(t)
α,β and γ: parameter

Under the assumption that the logistic curve has a ceiling at around 40 %, value of γ was given 0.4. Then the least square estimation gives α of –2.1341 and β of 4.2187 with R=0.987 using the following data.

	A	B	C	D
1	Year	GDP(VND bill.)	Investment(VND bill.)	Population(thou. Pers)
2	1990	125729	22386	66233
3	1991	133224	24862	67774
4	1992	144743	34774	69405
5	1993	156427	61636	71025
6	1994	170254	59769	72509
7	1995	186499	58003	73962
8	1996	203919	66168	75355

Formula (3.2) was assumed to have the following linear form:

$$Y = \alpha X + \beta \qquad (3.9)$$

where,

Y: Y(t)/N_h'(t)
X: K(t-1)/N(t)
α and β: parameter

It was assumed that annual working hours a worker were the same in 1990-1996 and were regarded as 1. Thus N_h'(t) is the same as N(t) in 1990-1996. However it should be arranged according to the change in annual working hours a worker in the future. In addition, as accumulated capital stock (K) in 1989 is unknown, some assumptions were adopted as follows:

- All Sectors: As of 1989, K is identical with 30% of the total investment 1990-1996.
- Primary Sector: As of 1989, K is identical with 100% of the primary sector investment 1990-1996.
- Secondary Sector: As of 1989, K is identical with 50% of the secondary sector investment 1990-1996.
- Tertiary Sector: As of 1989, K is identical with 20% of the tertiary sector investment 1990-1996.

In addition, it should be noted that ΔK indicating increase in capital was assumed at 0.666 for all sectors and 1.0 for the rest because of constraint of data on capital stock. As a result, the least square estimation gives the following parameter estimation using below data:

- All Sectors : $\alpha = 0.3442$, $\beta = 3.088$ and $R = 0.996$
- Primary Sector : $\alpha = 0.3687$, $\beta = 1.4670$ and $R = 0.966$
- Secondary Sector : $\alpha = 0.2380$, $\beta = 3.4774$ and $R = 0.990$
- Tertiary Sector : $\alpha = 0.2879$, $\beta = 10.3469$ and $R = 0.997$

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Year	Total GDP	(primary)	(secondary	(tertiary)	Toal Invest	(primary)	(secondary	(tertiary)	Toal Emplo	(primary)	(secondary	(tertiary)
2	1990	125729	42161	31871	51698	22386	2747	9725	9914	30286	21889	4210	4187
3	1991	133224	42893	34602	56729	24862	2758	12283	9822	30974	22483	4214	4277
4	1992	144743	45846	39385	59511	34774	3081	18730	12963	31815	23208	4275	4332
5	1993	156427	47384	44355	64689	61536	3764	37201	20671	32718	23898	4370	4450
6	1994	170254	49000	50322	70933	59769	3689	24356	31725	33664	24511	4575	4578
7	1995	186499	51282	57094	78123	58003	4667	21208	32139	34590	24122	4582	5886
8	1996	203919	53539	65000	85380	66168	4867	27537	33764	35792	24775	4629	6388
9	Total	1120795	332105	322628	456062	327499	25563	151039	150897	229839	164886	30856	34098
10	Note: VND bill. And thou. Pers.												
11													
12	Year	Y/(t)Lh'(t)	(primary)	(secondary	(tertiary)	K(t)	(primary)	(secondary	(tertiary)	K(t-1)/N(t)	(primary)	(secondary	(tertiary)
13	1989					98250	25563	75620	30179				
14	1990	4.15	1.93	7.67	12.35	113159	28310	85245	40093	3.24	1.17	17.94	7.21
15	1991	4.30	1.91	8.21	13.03	129717	31068	97528	49915	3.65	1.26	20.23	9.37
16	1992	4.66	1.98	9.21	13.74	162877	34149	116253	62878	4.08	1.34	22.81	11.62
17	1993	4.78	1.98	10.15	14.54	193860	37913	153459	83449	4.67	1.43	26.60	14.13
18	1994	5.06	2.00	11.00	15.49	233666	41602	177814	115174	5.76	1.55	33.54	18.23
19	1995	5.39	2.13	12.46	13.27	272296	46259	199022	147312	6.76	1.72	38.80	19.67
20	1996	5.70	2.16	14.04	13.37	316364	51126	226559	181076	7.61	1.87	43.00	23.06

Results Estimated

Most of all, it is should be noted that annual working hours were assumed and calculated as follows:

	A	B	C	D	E	F	G	H	I	J	K	L
1	Year	Sunday	Holiday	Saturday	Paid Holida	Total	Working	Daily W.H.	Annual W.H	Population	N(t)	Lh'(t)
2	1997	52	8	26.0	3.9	89.9	275.1	7.5	2063	78059	38249	38249
3	1998	52	8	26.8	4.0	90.8	274.2	7.4	2039	78864	38340	38432
4	1999	52	8	27.7	4.1	91.8	273.2	7.4	2014	79677	38427	38606
5	2000	52	8	28.6	4.2	92.7	272.3	7.3	1990	80499	38509	38771
6	2001	52	8	29.5	4.3	93.7	271.3	7.2	1966	81815	38816	39391
7	2002	52	8	30.4	4.4	94.7	270.3	7.2	1941	83152	39120	40011
8	2003	52	8	31.4	4.5	95.8	269.2	7.1	1917	84512	39420	40628
9	2004	52	8	32.3	4.6	96.9	268.1	7.1	1893	85893	39717	41242
10	2005	52	8	33.4	4.7	98.0	267.0	7.0	1869	87297	40010	41851
11	2006	52	8	34.4	4.8	99.2	265.8	7.0	1861	88702	40636	43173
12	2007	52	8	35.5	4.9	100.4	264.6	7.0	1852	90128	41266	44521
13	2008	52	8	36.6	5.0	101.6	263.4	7.0	1844	91578	41898	45894
14	2009	52	8	37.8	5.1	102.9	262.1	7.0	1835	93051	42531	47293
15	2010	52	8	39.0	5.2	104.2	260.8	7.0	1826	94548	43167	48716
16	2011	52	8	40.1	5.3	105.5	259.5	7.0	1817	95678	43640	49792
17	2012	52	8	41.3	5.4	106.8	258.2	7.0	1808	96821	44112	50873
18	2013	52	8	42.5	5.6	108.1	256.9	7.0	1798	97977	44580	51959
19	2014	52	8	43.8	5.7	109.4	255.6	7.0	1789	99148	45045	53048
20	2015	52	8	45.0	5.8	110.9	254.1	7.0	1779	100332	45505	54138
21	2016	52	8	46.3	5.9	112.3	252.7	7.0	1769	102106	46137	55652
22	2017	52	8	47.7	6.1	113.8	251.2	7.0	1759	103912	46768	57183
23	2018	52	8	49.1	6.2	115.3	249.7	7.0	1748	105749	47396	58731
24	2019	52	8	50.5	6.4	116.9	248.1	7.0	1737	107619	48023	60293
25	2020	52	8	52.0	6.5	118.5	246.5	7.0	1726	109521	48646	61868

Making use of formulae (3.8) and (3.9), national GDP are estimated as follows:

31	Year	Y(t)	Y(t)/P(t)	K(t-1)/N(t)	Y(t)/Nh'(t)	I(t)/Y(t)	I(t)	DK(t)	K(t)	P(t)	N(t)	Nh'(t)	h
32	1997	221872	2.84	8.27	5.80	0.346	76670	51113	367477	78059	38249	38249	0.67
33	1998	245479	3.11	9.58	6.39	0.367	90210	59819	426296	78864	38340	38432	0.65
34	1999	266644	3.35	11.09	6.91	0.380	101221	64549	490845	79677	38427	38606	0.64
35	2000	289834	3.60	12.75	7.48	0.388	112422	70117	560962	80499	38509	38771	0.62
36	2001	317601	3.88	14.45	8.06	0.393	124901	76189	637151	81815	38816	39391	0.61
37	2002	347871	4.18	16.29	8.69	0.396	137907	82275	719426	83152	39120	40011	0.60
38	2003	380686	4.50	18.25	9.37	0.398	151587	88450	807876	84512	39420	40628	0.58
39	2004	416117	4.84	20.34	10.09	0.399	166082	94779	902655	85893	39717	41242	0.57
40	2005	454253	5.20	22.56	10.85	0.400	181516	101312	1003967	87297	40010	41851	0.56
41	2006	500474	5.64	24.71	11.59	0.400	200109	109236	1113203	88702	40636	43173	0.55
42	2007	550883	6.11	26.98	12.37	0.400	220323	117629	1230832	90128	41266	44521	0.53
43	2008	605813	6.62	29.38	13.20	0.400	242313	126527	1357359	91578	41898	45894	0.52
44	2009	665681	7.16	31.91	14.07	0.400	266228	135961	1493320	93051	42531	47293	0.51
45	2010	730550	7.73	34.59	15.00	0.400	292219	145957	1639277	94548	43167	48716	0.50
46	2011	797563	8.34	37.56	16.02	0.400	319025	155846	1795122	95678	43640	49792	0.49
47	2012	869722	8.98	40.69	17.10	0.400	347889	166213	1961336	96821	44112	50873	0.48
48	2013	947322	9.67	44.00	18.23	0.400	378929	177067	2138402	97977	44580	51959	0.47
49	2014	1030664	10.40	47.47	19.43	0.400	412265	188413	2326816	99148	45045	53048	0.46
50	2015	1120051	11.16	51.13	20.69	0.400	448021	200256	2527071	100332	45505	54138	0.45
51	2016	1221097	11.98	54.77	21.94	0.400	488439	213527	2740598	101919	46137	55652	0.44
52	2017	1330034	12.85	58.60	23.26	0.400	532014	227468	2968066	103531	46768	57183	0.43
53	2018	1447343	13.76	62.62	24.64	0.400	578937	242093	3210159	105168	47396	58731	0.42
54	2019	1573520	14.73	66.85	26.10	0.400	629408	257417	3467576	106832	48023	60293	0.41
55	2020	1709072	15.75	71.28	27.62	0.400	683629	273452	3741028	108521	48646	61868	0.40

Likewise, national GDP at both low and high assumption scenarios is calculated only by changing investment per GDP rate (I(t)/Y(t)) and its results are shown as follows:

29	Low Assumption												
30													
31	Year	Y(t)	Y(t)/P(t)	K(t-1)/N(t)	Y(t)/Nh'(t)	I(t)/Y(t)	I(t)	DK(t)	K(t)	P(t)	N(t)	Nh'(t)	h
32	1997	221872	2.84	8.27	5.80	0.346	76670	51113	367477	78059	38249	38249	0.67
33	1998	245479	3.11	9.58	6.39	0.320	78553	51219	418696	78864	38340	38432	0.65
34	1999	264016	3.31	10.90	6.84	0.310	81845	52193	470698	79677	38427	38606	0.64
35	2000	282918	3.51	12.23	7.30	0.250	70730	44114	515002	80499	38509	38771	0.62
36	2001	301547	3.69	13.27	7.66	0.250	75387	45985	560987	81815	38816	39391	0.61
37	2002	321057	3.86	14.34	8.02	0.250	80264	47885	608873	83152	39120	40011	0.60
38	2003	341467	4.04	15.45	8.40	0.250	85367	49811	658684	84512	39420	40628	0.58
39	2004	362792	4.22	16.58	8.80	0.250	90698	51759	710443	85893	39717	41242	0.57
40	2005	385046	4.41	17.76	9.20	0.250	96261	53727	764170	87297	40010	41851	0.56
41	2006	412781	4.65	18.81	9.56	0.240	99067	54079	818249	88702	40636	43173	0.55
42	2007	441355	4.90	19.83	9.91	0.230	101512	54196	872445	90128	41266	44521	0.53
43	2008	470685	5.14	20.82	10.26	0.220	103551	54070	926516	91579	41898	45894	0.52
44	2009	500676	5.38	21.78	10.59	0.210	105142	53696	980211	93051	42531	47293	0.51
45	2010	531225	5.62	22.71	10.90	0.200	106245	53067	1033278	94548	43167	48716	0.50
46	2011	559569	5.85	23.68	11.24	0.200	111914	54671	1087949	95678	43640	49792	0.49
47	2012	588994	6.08	24.66	11.58	0.200	117799	56281	1144230	96821	44112	50873	0.48
48	2013	619511	6.32	25.67	11.92	0.200	123902	57897	1202128	97977	44580	51959	0.47
49	2014	651128	6.57	26.69	12.27	0.200	130226	59515	1261643	99148	45045	53048	0.46
50	2015	683850	6.82	27.73	12.63	0.200	136770	61133	1322777	100332	45505	54138	0.45
51	2016	721078	7.08	28.67	12.96	0.200	144216	63046	1385822	101919	46137	55652	0.44
52	2017	759848	7.34	29.63	13.29	0.200	151970	64976	1450798	103531	46768	57183	0.43
53	2018	800184	7.61	30.61	13.62	0.200	160037	66922	1517721	105168	47396	58731	0.42
54	2019	842107	7.88	31.60	13.97	0.200	168421	68882	1586602	106832	48023	60293	0.41
55	2020	885633	8.16	32.62	14.31	0.200	177127	70851	1657453	108521	48646	61868	0.40

29	High Assumption												
30													
31	Year	Y(t)	Y(t)/P(t)	K(t-1)/N(t)	Y(t)/Nh'(t)	I(t)/Y(t)	I(t)	DK(t)	K(t)	P(t)	N(t)	Nh'(t)	h
32	1997	221872	2.84	8.27	5.80	0.346	76670	51113	367477	78059	38249	38249	0.67
33	1998	245479	3.11	9.58	6.39	0.320	78553	51219	418696	78864	38340	38432	0.65
34	1999	264016	3.31	10.90	6.84	0.320	84485	53876	472572	79677	38427	38606	0.64
35	2000	283502	3.52	12.27	7.31	0.320	90721	56582	529154	80499	38509	38771	0.62
36	2001	306490	3.75	13.63	7.78	0.310	95012	57957	587111	81815	38816	39391	0.61
37	2002	330254	3.97	15.01	8.25	0.310	102379	61079	648189	83152	39120	40011	0.60
38	2003	355415	4.21	16.44	8.75	0.310	110179	64288	712478	84512	39420	40628	0.58
39	2004	382019	4.45	17.94	9.26	0.300	114606	65403	777880	85893	39717	41242	0.57
40	2005	409327	4.69	19.44	9.78	0.300	122798	68539	846419	87297	40010	41851	0.56
41	2006	442859	4.99	20.83	10.26	0.300	132858	72525	918944	88702	40636	43173	0.55
42	2007	478749	5.31	22.27	10.75	0.290	138837	74124	993068	90128	41266	44521	0.53
43	2008	516165	5.64	23.70	11.25	0.290	149688	78162	1071229	91578	41898	45894	0.52
44	2009	556065	5.98	25.19	11.76	0.290	161259	82354	1153583	93051	42531	47293	0.51
45	2010	598574	6.33	26.72	12.29	0.280	167601	83713	1237296	94548	43167	48716	0.50
46	2011	639693	6.69	28.35	12.65	0.280	179114	87498	1324794	95678	43640	49792	0.49
47	2012	683015	7.05	30.03	13.43	0.280	191244	91372	1416166	96821	44112	50873	0.48
48	2013	728608	7.44	31.77	14.02	0.280	204010	95330	1511497	97977	44590	51959	0.47
49	2014	776536	7.83	33.56	14.64	0.280	217430	99370	1610866	99148	45045	53048	0.46
50	2015	826861	8.24	35.40	15.27	0.280	231521	103465	1714352	100332	45605	54138	0.45
51	2016	883659	8.67	37.16	15.88	0.280	247424	108165	1822516	101919	46137	55652	0.44
52	2017	943640	9.11	38.97	16.50	0.280	264219	112969	1935486	103531	46768	57183	0.43
53	2018	1006917	9.57	40.84	17.14	0.280	281937	117897	2053383	105168	47396	58731	0.42
54	2019	1073601	10.05	42.76	17.81	0.280	300608	122944	2176327	106832	48023	60293	0.41
55	2020	1143799	10.54	44.74	18.49	0.280	320264	128105	2304432	108521	48646	61868	0.40

Regional Breakdown

The basic approach to regional breakdown is as follows:

- Calculate the number of workers (N(t)) by sector and by region.
- Calculate labor productivity (Y(t)/N(t)) by sector and by region.
- GDP by region is obtained by multiplying the number of workers and labor productivity.

Based on some assumptions, the number or worker and the labor productivity were calculated as follows:

	The Employment							
(1)	Primary Sector							
		1995	1997	2000	2005	2010	2015	2020
	Red River Delta		4,978	5,045	5,159	5,275	5,208	5,141
	North East		4,806	4,871	4,991	5,093	5,028	4,964
	North West		1,024	1,037	1,061	1,085	1,071	1,057
	North Central Coast		3,779	3,830	3,916	4,005	3,954	3,903
	South Central Coast		2,099	2,116	2,164	2,213	2,184	2,156
	Central Highlands		906	918	939	950	947	935
	North East South		2,286	2,317	2,369	2,423	2,392	2,361
	Mekong River Delta		5,319	5,390	5,512	5,636	5,564	5,493
	Total		25,186	25,525	26,100	26,688	26,347	26,011
(2)	Secondary Sector							
		1995	1997	2000	2005	2010	2015	2020
	Red River Delta		794	834	904	981	1,051	1,126
	North East		296	311	337	366	392	420
	North West		17	17	19	20	22	23
	North Central Coast		350	368	399	433	463	497
	South Central Coast		336	355	385	418	447	479
	Central Highlands		41	43	46	50	54	58
	North East South		1,241	1,303	1,412	1,532	1,641	1,758
	Mekong River Delta		750	788	854	926	992	1,063
	Total		3,828	4,019	4,358	4,726	5,063	5,424
(3)	Tertiary Sector							
		1995	1997	2000	2005	2010	2015	2020
	Red River Delta		1,881	2,186	2,807	3,605	4,435	5,456
	North East		708	823	1,057	1,358	1,671	2,055
	North West		106	123	158	203	249	307
	North Central Coast		816	949	1,219	1,565	1,925	2,368
	South Central Coast		866	1,006	1,293	1,660	2,042	2,512
	Central Highlands		188	219	281	361	444	547
	North East South		2,411	2,801	3,598	4,621	5,685	6,993
	Mekong River Delta		2,258	2,624	3,370	4,328	5,324	6,549
	Total		9,235	10,731	13,782	17,702	21,775	26,785

	Labor Productivity by Region (based on Low Case)							
(1)	Primary Sector							
		1995	1997	2000	2005	2010	2015	2020
	Red River Delta		2.18	2.65	2.93	3.54	4.03	4.59
	North East		1.03	1.21	1.42	1.68	1.91	2.18
	North West		0.33	0.39	0.46	0.54	0.61	0.70
	North Central Coast		1.58	1.85	2.17	2.57	2.92	3.32
	South Central Coast		2.20	2.57	3.02	3.57	4.06	4.63
	Central Highlands		2.88	3.37	3.95	4.68	5.32	6.06
	North East South		5.32	6.23	7.31	8.65	9.84	11.20
	Mekong River Delta		3.29	3.85	4.62	5.34	6.08	6.92
	Total		2.22	2.60	3.05	3.61	4.10	4.67
(2)	Secondary Sector							
		1995	1997	2000	2005	2010	2015	2020
	Red River Delta		14.74	18.59	24.66	32.88	41.06	51.20
	North East		30.67	39.68	51.31	68.41	85.44	106.54
	North West		65.79	82.97	110.07	146.74	183.27	228.53
	North Central Coast		14.95	18.85	25.00	33.34	41.64	51.92
	South Central Coast		10.76	13.57	18.01	24.00	29.98	37.38
	Central Highlands		59.91	75.56	100.24	133.64	166.91	208.12
	North East South		16.15	20.37	27.02	36.02	44.99	56.09
	Mekong River Delta		10.08	12.71	16.87	22.48	28.08	35.02
	Total		19.20	24.21	32.12	42.82	53.49	66.69
(3)	Tertiary Sector							
		1995	1997	2000	2005	2010	2015	2020
	Red River Delta		10.18	11.30	12.21	13.36	14.24	15.27
	North East		16.23	18.02	19.47	21.30	22.71	24.35
	North West		9.50	10.54	11.39	12.46	13.28	14.25
	North Central Coast		14.03	15.57	16.82	18.41	19.62	21.04
	South Central Coast		6.96	7.73	8.34	9.13	9.73	10.44
	Central Highlands		12.94	14.36	15.51	16.97	18.09	19.41
	North East South		9.67	10.73	11.59	12.68	13.62	14.60
	Mekong River Delta		4.67	5.18	5.59	6.12	6.53	7.00
	Total		10.01	11.12	12.00	13.14	14.00	15.02

GDP Data

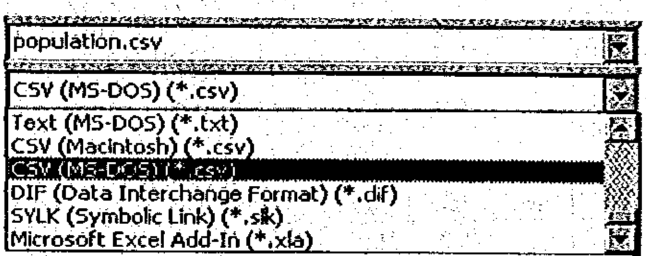
Through above steps, GDP was estimated at province level and its data was kept as Excel file (gdp.xls) with the following information.

Table 3.2
VITRANSS GRDP Data

Year	Data Name	Data Coding
	Zone No.	Zone No.
	Province Name	Province Name
1999	GDP	Primary GDP by Province (VND bill.)
	Primary GDP	Secondary GDP by Province (VND bill.)
	Secondary GDP	Tertiary GDP by Province (VND bill.)
	Tertiary GDP	GDP by Province (VND bill.)
2010	Primary GDP-L	Primary GDP by Province at Low Assumption (VND bill.)
	Secondary GDP-L	Secondary GDP by Province at Low Assumption (VND bill.)
	Tertiary GDP-L	Tertiary GDP by Province at Low Assumption (VND bill.)
	GDP-L	GDP by Province at Low Assumption (VND bill.)
	Primary GDP-H	Primary GDP by Province at High Assumption (VND bill.)
	Secondary GDP-H	Secondary GDP by Province at High Assumption (VND bill.)
	Tertiary GDP-H	Tertiary GDP by Province at High Assumption (VND bill.)
	GDP-H	GDP by Province at High Assumption (VND bill.)
2020	Primary GDP-L	Primary GDP by Province at Low Assumption (VND bill.)
	Secondary GDP-L	Secondary GDP by Province at Low Assumption (VND bill.)
	Tertiary GDP-L	Tertiary GDP by Province at Low Assumption (VND bill.)
	GDP-L	GDP by Province at Low Assumption (VND bill.)
	Primary GDP-H	Primary GDP by Province at High Assumption (VND bill.)
	Secondary GDP-H	Secondary GDP by Province at High Assumption (VND bill.)
	Tertiary GDP-H	Tertiary GDP by Province at High Assumption (VND bill.)
	GDP-H	GDP by Province at High Assumption (VND bill.)

Note: To make use of above GRDP as exogenous variable in other sub-models, one should transform excel file (*.xls) into csv file (*.csv). To do this:

1. Click "file".
2. Click "Save As".
3. Find "CSV (MS-DOS).csv".



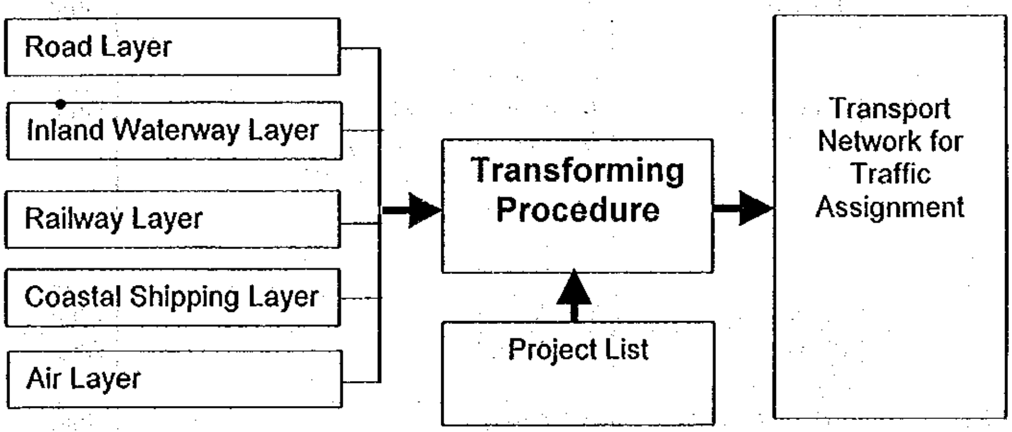
4. Input new file name and save.

4 NETWORK BUILDING SUB-MODEL

4.1 General

Transport network inventories provide the basic information on establishing transport network that is used as a tool to determine traffic flows at present or in future. The inventories consist of five modes' layers of locating and describing each link. The description of each link includes a measure of link capacity and condition, and a statement of its performance characteristics. Those inventories were all compiled into "Mapinfo" file format and enable to make transport network for traffic assignment represented as "JICA STRADA" file format. Interaction between transport inventory data and transport network for traffic assignment is illustrated in Figure 4.1. A tool of transforming procedure, which was developed in the VITRANSS study, transforms "Mapinfo" files of road, inland waterway, railway, coastal shipping and air layers into a transport network of "JICA STRADA" file and, as a result, enables to make the transport network for traffic assignment with simple operation.

Figure 4.1
Interaction between Modes' Layers and Transport Network



4.2 Network Database

Network Inventory

Transport network inventory data has been built in "Mapinfo", a kind of GIS software, which enables users to update the database, create thematic maps, perform geographic analysis and give graphic presentations. As mentioned earlier, it consists of five modes' layers, i.e., road, inland waterway, railway, coastal shipping and air route. The modes' layers are composed of a set of line objects and polyline objects, with each object representing road section, railway segment, air route and so on. Also each link contains information on geographical characteristics, modes' characteristics and land use.

The inventory of each layer is summarized as Table 4.1 and 4.2

Table 4.1
VITRANSS Road Network Data

Category	Data Name	Data Coding	Type	Digits
Basic Data	Link No.	Link No.	Char.	5
	Road Class	N: National Road P: Provincial Road	Char.	5
	Road No.	Road No.	Char.	5
	Province Name	Province Name	Char.	10
Physical	Length	Link Length (km)	Decimal	
Condition	Pavement Width	Pavement Width (m)	Decimal	
	Pavement Type	A: Asphalt Concrete C: Concrete B: Bitumen G: Gravel L: Laterite E: Earth	Char.	5
	Surface Condition	A: Very-Good B: Good C: Fair D: Poor E: Very-Poor	Char.	5
	Terrain	F: Flat H: Hilly M: Mountainous	Char.	5
	Land Use	A: Rural, no activity B: Rural, some activity C: Semi-urban, residential D: Semi-urban E: Urban	Char.	5
Environmental	River Flood	Y: affected	Char.	5
Condition	Storm Surges	Y: affected	Char.	5
	Biodiversity Hotspots	Y: affected	Char.	5
Data for VITRANSS Model	VITRANSS Class	P: Primary S: Secondary T: Tertiary	Char.	5
	Link Type	R: Road B+No.: Bridge (more than 100m) F+No.: Ferry (more than 500m) Z+No.: Dummy Link for centroid	Char.	5
	Access	A: Airport Access Link P: Port Access Link C: Cross-Border Link	Char.	5
	Project No.	No.: VITRANSS Master Plan Project No.	Char.	5
	Corridor No.	No.: Corridor No.	Char.	5
	Assignment	Y: Used for assignment network N: Not used for assignment network	Char.	5
	Present Traffic Volume (1999)	No. of vehicles (Result of VITRANSS Traffic Survey)	Decimal	

Note: Code 999 is encoded in "Length", "Pavement Width", "Pavement Type", "Surface Condition", "Terrain" and "Landuse" for the links which is not used for assignment.

Table 4.2
VITRANSS Network Data of Inland Water, Rail, Coastal Shipping and Air

Data Name	Data Coding	Type	Digits
Link Name	Link Name	Char.	5
Length	Link Length (km)	Decimal	
Presented Speed	Speed at Present Situation (km/h)	Decimal	
Present Capacity 1)	Link Capacity at Present Situation	Decimal	
Future Speed	Speed after Project Taken (km/h)	Decimal	
Future Capacity 1)	Link capacity after Project Taken	Decimal	
Link Type	**Inland Water** 1-6: Inland Waterway D 2): Dummy Link **Rail** L: Railway D 2): Dummy Link N: New Construction B: Bridge (New) **Coastal Shipping** C: Coastal Shipping Route D 2): Dummy Link **Air** A: Air Route D 2): Dummy Link N: New Air Route	Char.	5
Project No	No: VITRANSS Master Plan Project No	Char.	5
Assignment	Y: Used for assignment network N: Not used for assignment network	Char.	5
Present Traffic Volume (1999)	(Results of VITRANSS Traffic Survey)	Decimal	

Note:
1) Only railway links have capacity. Regarding inland water and coastal shipping, port capacity has strong impact on usage of their routes.
2) In basic, all dummy links are connected with road links except those of coastal shipping. They are connected with either road links or Inland Water links.

An example of transport network is depicted in Figure 4.2

Network Checking

One should bear in mind that a specific link should be connected with another link(s) except link with centroid. For instance, in the figure below, two links seem to be connected together at a glance. But they are disconnected.

Note: To ensure links to connect together, it is recommendable to make use of "Snap to Nodes" function in Mapinfo. In the Mapinfo window, regions, polylines, lines, a arcs and rectangles all have nodes that can be attached (or snapped) to each other. When the Snap to Nodes option is enabled, Mapinfo searches for these nodes as you move a node. Mapinfo automatically snaps the cursor to a node in an object when the cursor comes within a certain distance of the node. To active Snap to Nodes, press the S key.

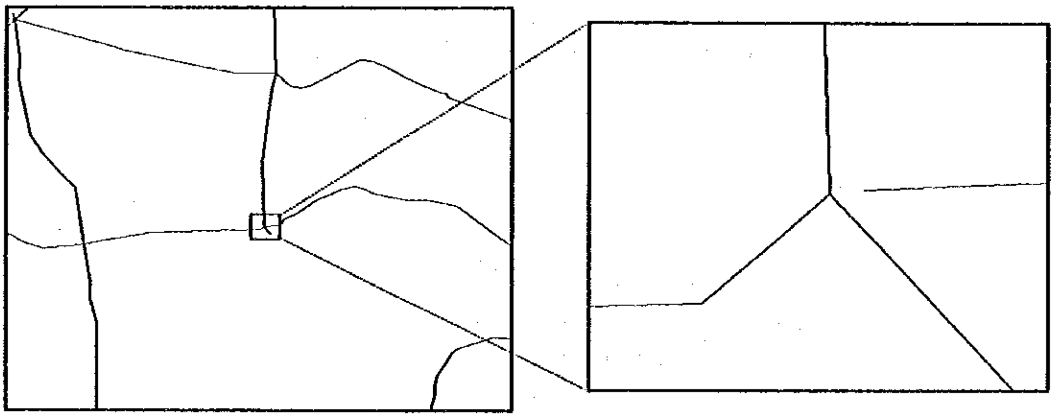
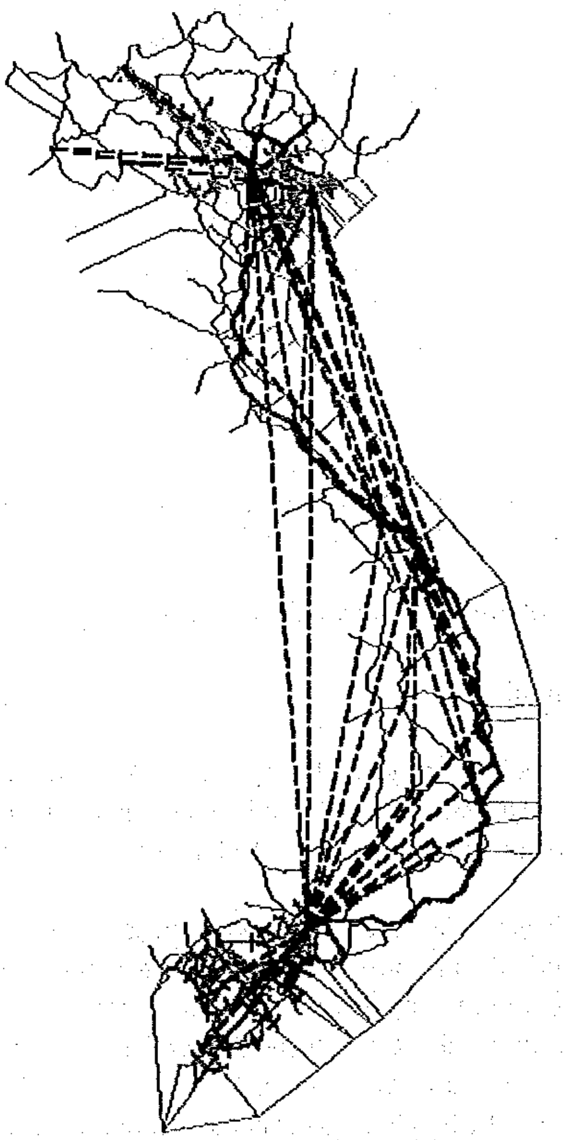
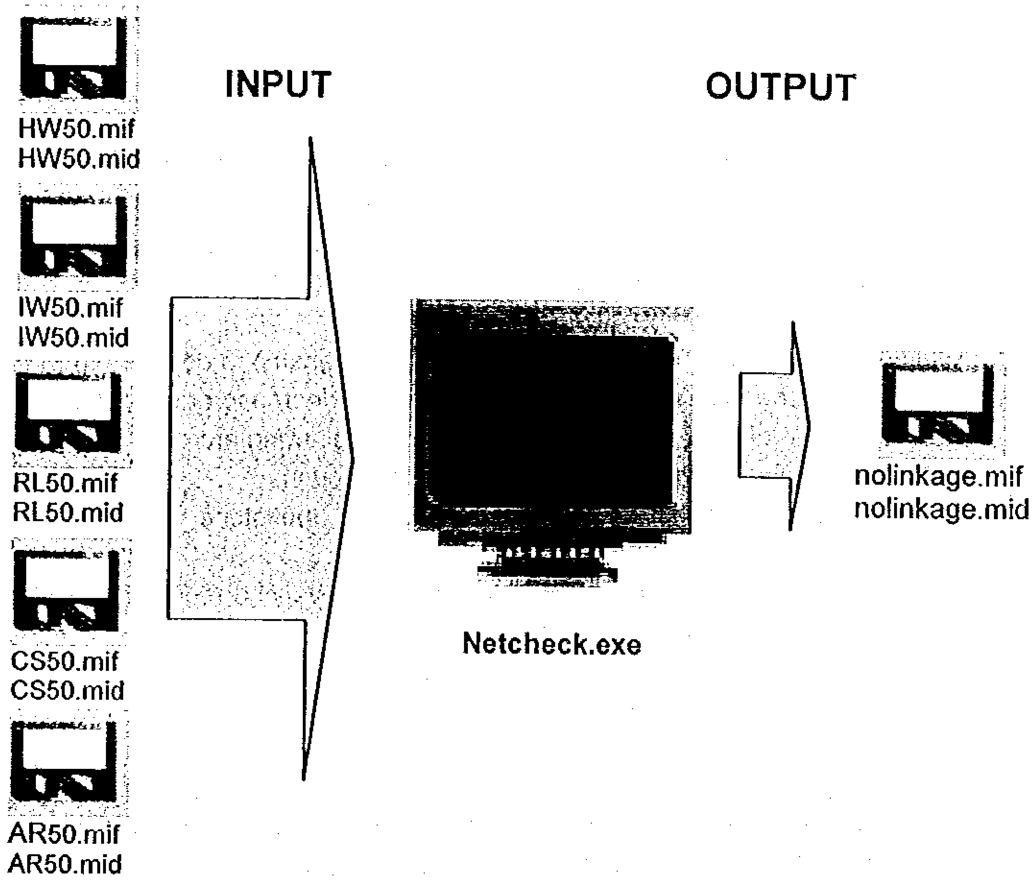


Figure 4.2
At A Glance of Transport Network

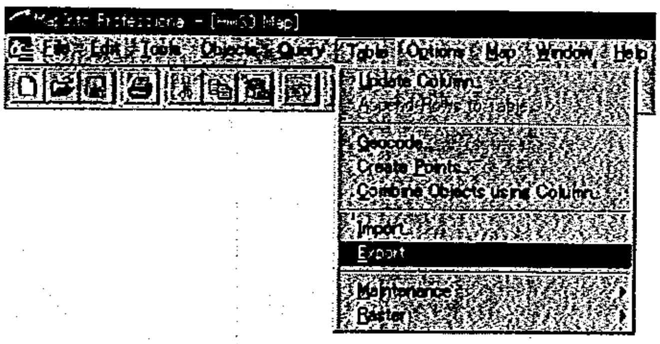


To cope with this kind of problem, a program of checking network was developed and it is executed through the following steps.

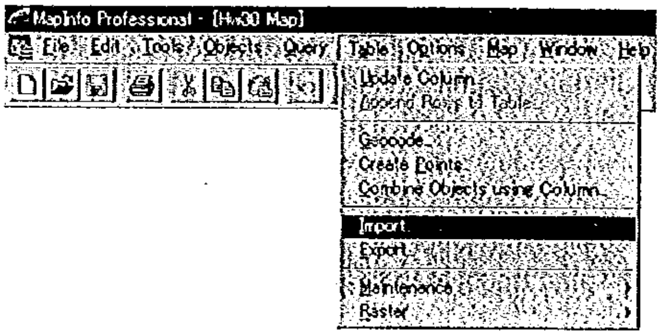
i) Create *.mif and *.mid files for five modes' layers.
ii) Execute netcheck executive file (netcheck.exe), and two files of "nolinkage.mif" and "nolinkage.mid" will be created.
iii) Import those two files into Mapinfo
iv) Links that have some troubles are represented with red or yellow.



Note: To create *.mif and *.mid files, one should use a command of "export".



Note: To open *.mif and timid files in Mapinfo, one should use a command of "import".



4.3 QC Curve

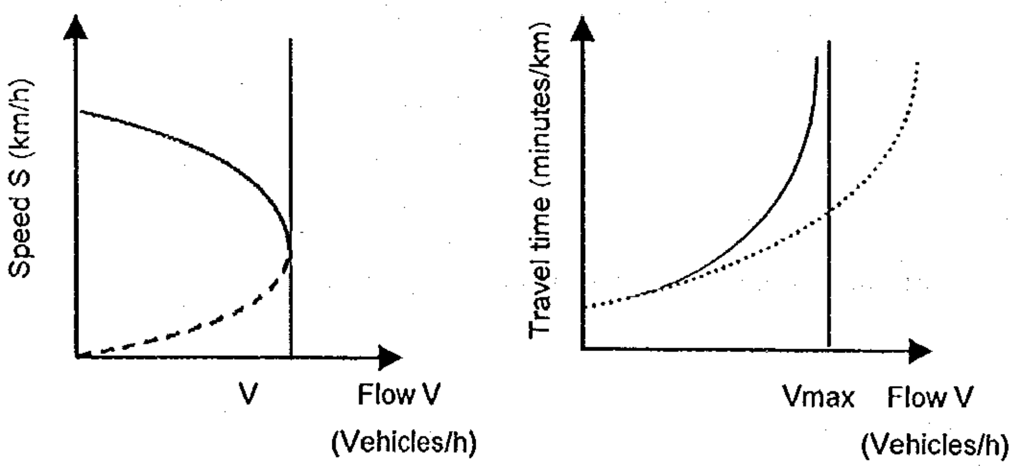
For traffic assignment calculation, data on both demand and supply sides are needed. In general, data on demand side are described as OD tables whereas data on supply side are represented by links and their costs such as distance, free-flow speed, and capacity and speed-flow relationship.

Typical speed-flow (QV) and cost-flow (QC) relationship is depicted in Figure 4.2; as traffic volume increases, travel speed tends to decrease or travel time increase. From the point of view of traffic assignment, the following are desirable properties.

- The modeled travel times should be realistic enough;
- The function should be non-decreasing and monotone, i.e., increasing flow should not reduce travel time;
- The function should allow the existence of an overload region, i.e., it should not generate infinite travel time; and
- For practical reasons the cost-flow relationship should be easy to transfer from one context to another.

In practice, many kinds of QV curves and QC curves have so far been proposed all of which tried to reflect these properties. In case of JICA STRADA, for instance, nine types of QV curves, BPR function and Davison function are among one's choice sets.

Figure 4.2
Typical Speed-flow and Cost-flow Relationship

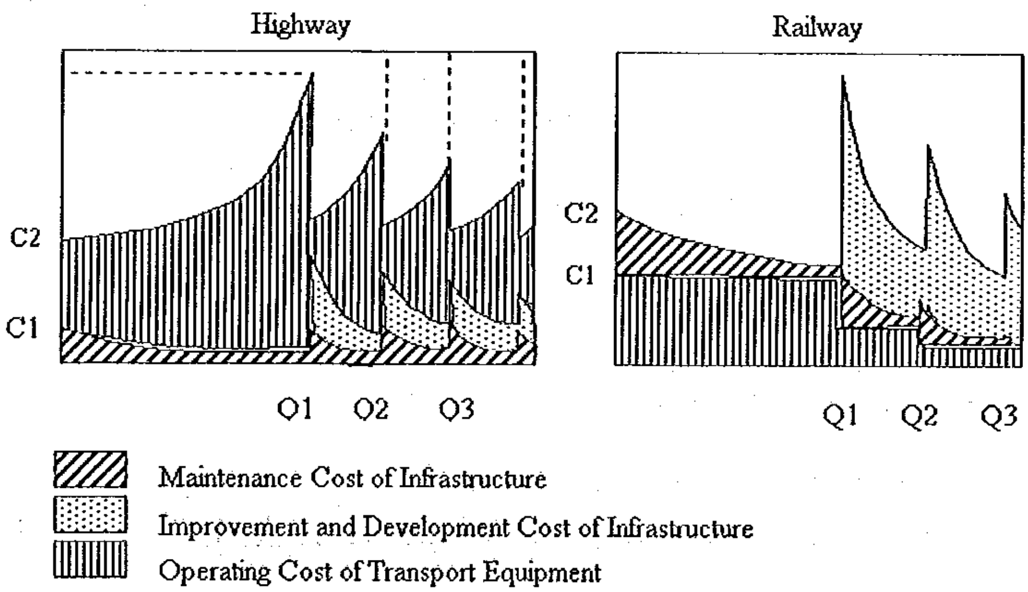


However, QC curves used in the VITRANSS study were epoch-making enough to change its traditional concept in fact that they included not only speed relevant factors but also operating cost consisting of transport equipment, loading/unloading cost and cargo time cost, maintenance cost and infrastructure cost. They are classified into three types according to their purpose.

QC Curve 1

This type of QC curve allows infrastructure extension while doing traffic assignment calculation, i.e., when traffic flow approaches capacity, the capacity will be automatically extended according to the rules in advance given, e.g. from 2-lane to 4-lane, requiring construction cost. As a result, one can calculate operating cost, maintenance cost and infrastructure cost from the assignment results. Transport demand was forecast using this type of QC curves. Its representative pattern is illustrated in Figure 4.3.

Figure 4.3
Typical Pattern of QC Curve



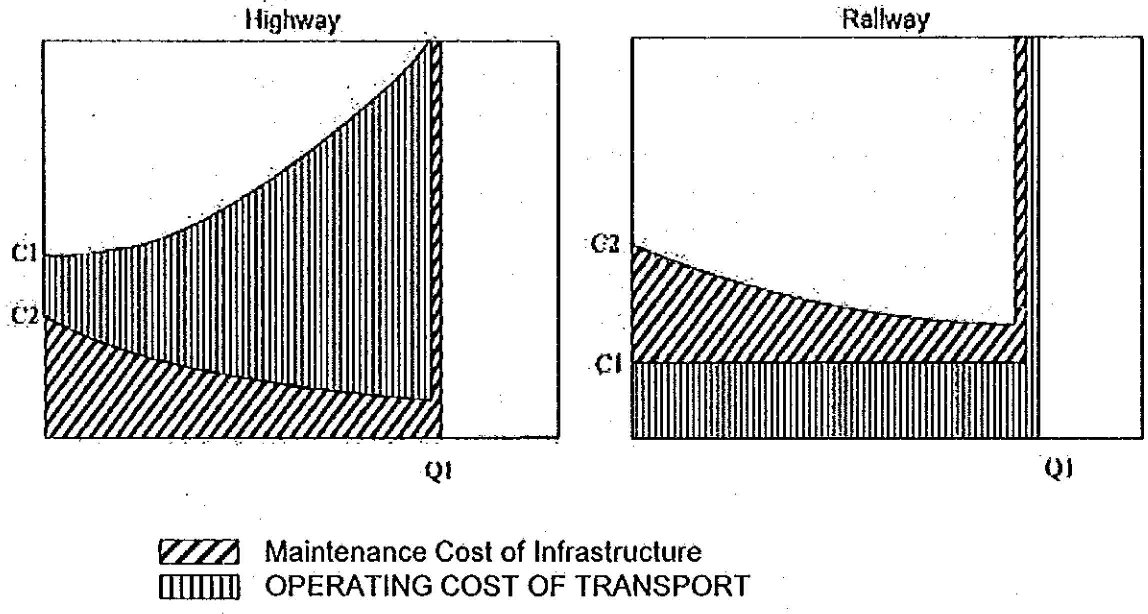
QC Curve 2

This type of QC curve does not allow infrastructure extension and, as a result, as traffic volume approaches capacity, transport cost becomes such a tremendous amount that traffic will be assigned on the alternative routes or modes. This is very effective when one wants to evaluate a specific project through before-after method. Its representative pattern is illustrated in Figure 4.4.

QC Curve 3

This is a combination of QC curve 1 and 2, i.e. some links have type of QC curve 1 and others have type of QC curve 2. This is very effective when one wants to evaluate a case where investment is allowed only to a specific mode. For example, suppose that all budgets are invested to road sector or rail sector. Through a comparison of their benefits obtained from each case, decision maker can roughly determine their priority.

Figure 4.4
Typical Pattern of QC Curve 2

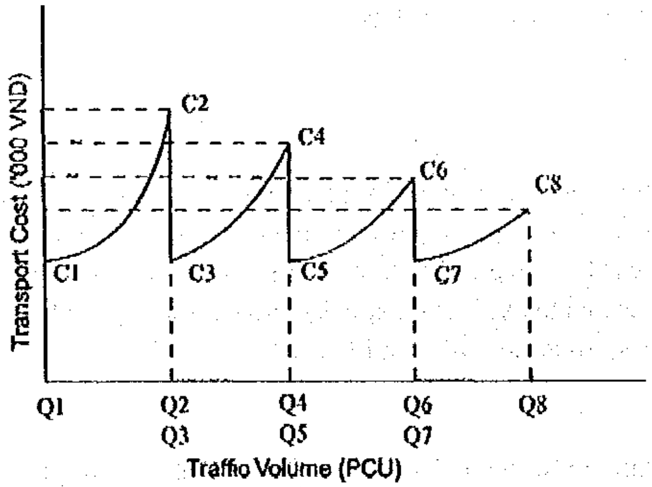


An Example of Making QC Curve

Suppose that a certain link has the following attributes:

- Link length: 3.0 km
- Pavement width: 6 m
- Surface condition: D (poor)
- Terrain: H (Hilly)
- Side Friction: B (rural, some activities)

Then, the pattern becomes as follows in terms of QC curve 1.



Where, Q1: No traffic volume	C1: Transport Cost at Q1
Q2: Capacity at Present	C2: Transport Cost at Q2
Q3: Traffic Volume after rehabilitation	C3: Transport Cost at Q3
Q4: Capacity after rehabilitation	C4: Transport Cost at Q4
Q5: Traffic Volume after 4-lane widening	C5: Transport Cost at Q5
Q6: Capacity after 4-lane widening	C6: Transport Cost at Q6
Q7: Traffic Volume after 6-line widening	C7: Transport Cost at Q7
Q8: Capacity after 6-lane widening	C8: Transport Cost at Q8

The key is to determine Q_i and C_i. Note that transport cost consists of operating cost (CO), maintenance cost (CM) and infrastructure (or construction) cost (CI), i.e., C=CO+CM+CI. Also, note that each cost is usually calculated as follows.

- CO=unit cargo transport cost x link length x adjustment factor to running speed
- CM = (daily maintenance cost x link length)/traffic volume
- CI = daily construction cost/traffic volume

Thus, capacity and transport cost can be calculated through the following steps:

i) Step 1: Determining Q1 and C1
- Q1=0 because of zero traffic
- Operating Cost (CO1)
  CO1= unit cargo transport cost x link length x adjustment factor by running speed, thus operating cost=0.546x3.0x1.31
- Maintenance Cost (CM1)
  CM1= (maintenance cost x link length)/traffic volume, thus CM1=86000x3.0/365/Q1. Note that Q1 was assumed at 1,000 ton because, if zero traffic, CM1 will have unlimited value.
- Construction Cost (CI1)
  CI1=0 because of no investment
- As a result, transport cost, C1, is a summation of CO1, CM1, and CI1.

ii) Step 2: Determining Q2 and C2
- Q2, the capacity at present, is calculated considering the following factors:
  Basic Capacity (Co): 2.900 (PCU/hr)
  Adjustment factor for carriageway width (FCw): 0.91
  Adjustment factor for directional split (FCsp): 0.94
  Adjustment factor for motorcycle traffic (FCmc): 0.82
  Adjustment factor for side friction (FCsf): 0.90
  Adjustment factor for inter-provincial traffic (FCip): 0.6
  Adjustment factor for surface condition: 0.5
- As a result, Q2 can be obtained by multiplying all the adjustment factors. It should be noted that the value of 2 should be multiplied when changing PCU capacity to ton capacity from the relation between PCU, vehicle type and average loading weight.

- Operating Cost (CO2)
  CO2 is calculated in the same manner of CO1 but it should be noted that adjustment factor according to running speed is determined under the assumption of QV type 6 of JICA STRADA. Thus, CO2=0.546x3.0x2.01
- Maintenance Cost (CM2)
  CM2=86000x3/365/Q2
- Construction Cost (CI2)
  CI2 is still zero because of no investment.
- As a result, transport cost, C2, is a summation of CO2, CM2 and CI2.

iii) Step 3: Determining Q3 and C3

- Rehabilitation, by which surface condition changes into "good" or "very good" and pavement width, at least, extends up to 6m, has undertaken at this stage so that capacity extends to Q4, operating cost decreases because of improvement of travel condition and construction cost takes place.
- Q3 is the same as Q2.
- Operating Cost (CO3)
  Operating cost decrease because of improvement of traffic condition, i.e., adjustment factor to running speed changes. The running speed was calculated as follows:
  If Q3 < 0.3Q4, then running speed at Q3 is the same as that at Q4.
  If Q3 >= 0.3Q4, then running speed decreases in proportional to traffic volume.
  As a result, operation cost, CO3, can be calculated taking into account change in adjustment factor.
- Maintenance Cost (CM3)
  CM2=86000x3.0x2/365/Q3
- Construction Cost (CI3)
  As rehabilitation has undertaken, only pavement cost is needed. Thus, CI3=283000x3/365/Q3
- As a result, transport cost, C3, is a summation of CO3, CM3 and CI3.

iv) Step 4: Determining Q4 and C4

- Q4, capacity after rehabilitation, was assumed to extend up to 1.5 times than Q2. Thus, Q4=Q2x1.5
- Operating Cost (CO4)
  CO4 is calculated in the same manner of CO2 but it should be noted that adjustment factor according to running speed is determined under the assumption of QV type 6 of JICA STRADA. Thus, CO4=0.546x3.0x2.01
- Maintenance Cost (CM4)
  CM4=86000x3.0x2/365/Q4
- Construction Cost (CI4)
  CI4=283000x3/365/Q4
- As a result, transport cost, C4, is a summation of CO4, CM4 and CI4.

v) Step 5: Determining Q5 and C5

- Q5 is the same as Q4.
- Operating Cost (CO5)
  CO5 is calculated the same manner in CO3.
- Maintenance Cost (CM5)
  CM5=86000x3.0x3/365/Q5
- Construction Cost (CI5)
  As road has been widen to 4-lane, construction cost is required for its widening. Thus,
  CI5= 947000x2x3/365/Q5
- As a result, transport cost, C5, is a summation of CO5, CM5 and CI5.

vi) Step 6: Determining Q6 and C6

- Q6, capacity after widening from 2-lane to 4-lane, is calculated as the summation of Q4 and additional capacity by widening. Thus, Q6=Q4+34118x2x0.6
- Operating Cost (CO6)
  CO6 is calculated in the same manner of CO4.
- Maintenance Cost (CM6)
  CM6=86000x3.0x3/365/Q6
- Construction Cost (CI6)
  CI6= 947000x2x3/365/Q6
- As a result, transport cost, C6, is a summation of CO6, CM6 and CI6.

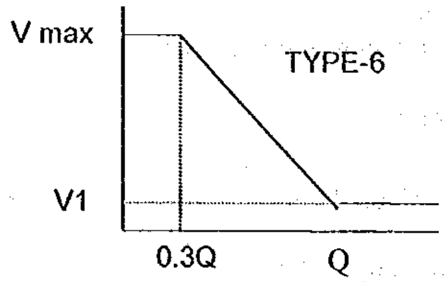
vii) Step 7: Determining Q7 and C7

- Q7 is the same as Q6.
- Operating Cost (CO5)
  CO7 is calculated the same manner in CO5.
- Maintenance Cost (CM5)
  CM7=86000x3.0x4/365/Q7
- Construction Cost (CI5)
  As road has been widen to 6-lane, construction cost is required for its widening. Thus,
  CI5= 947000x4x3/365.0/Q7
- As a result, transport cost, C7, is a summation of CO7, CM7 and CI7.

viii) Step 8: Determining Q8 and C8

- Q8, capacity after widening from 4-lane to 6-lane, is calculated as the summation of Q6 and additional capacity by widening. Thus, Q8=Q6+34118x2x0.6
- Operating Cost (CO6)
  CO8 is calculated in the same manner of CO6.
- Maintenance Cost (CM6)
  CM8=86000x3.0x4/365/Q8
- Construction Cost (CI6)
  CI8= 947000x4x3/365/Q8
- As a result, transport cost, C8, is a summation of CO8, CM8 and CI8.

Note: In calculating travel speed at Q2 to Q8, QV type 6 of JICA STRADA was applied and its pattern is as follows.



General Principle of Applying QC Curve

Regarding the type of QC curve 1, its capacity is extended as follows:

- The capacity of road with poor surface condition and ferry was extended through three steps, i.e., from capacity at present to capacity after rehabilitation, after widening to 4-lane and after widening to 6-lane.
- The capacity of road with good surface condition was extended through three steps, i.e., from capacity at present to capacity after widening to 4-lane, 6-lane and 8-lane.
- The capacity of railway was extended through two steps, i.e., from capacity at present to capacity after rehabilitation (electrification and communication facilities improvement) and after introducing double tracking.
- The capacity of port was extended incrementally through three steps.
- Regarding inland waterway, coastal shipping route and air route, only their operating cost was taken into account.

Regarding the type of QC curve 2, its pattern is determined with simple using capacity at present.

4.4 Network Building Operation

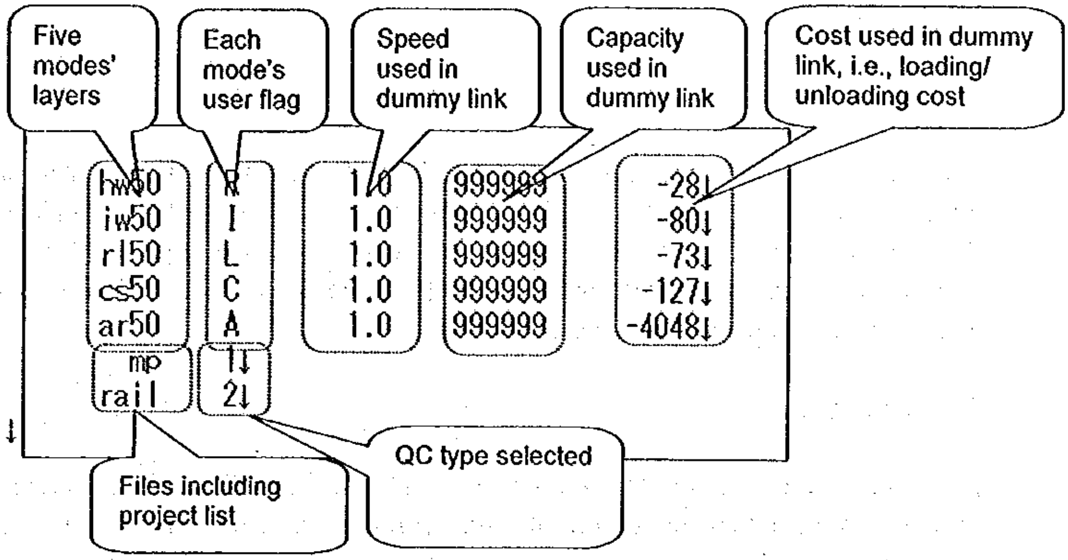
Network for traffic assignment and QC curves, as illustrated in Figure 4.5, are built by executing "MNetwork.exe" through the following steps:

- Reading parameter file;
- Reading transport modes' layers, including road, inland water, rail, coastal shipping and air;
- Creating both present network where no projects included and future network including not only on-going projects but also projects proposed in the VITRANSS study;
- Reading project files;
- Creating network and QC curve, by replacing links and their attributes of present network with those of future network for links which included in the project list; and
- Writing and saving network and QC curve.

Parameter File

Parameter file (MNetwork.par) includes file names to be read and information necessary for formulating assignment network and calculating QC curves.

Figure 4.5
Parameter File (MNetwork.par)



Five modes' layers are files of Mapinfo composed of "*.mif" and "*.mid".

Each mode's user flag is prepared for user flag column in JICA STRADA, which makes it useful to calculate transport related indices by mode such as passenger-km, ton-km, and transport cost required. "R", "I", "L", "C" and "A" mean road, inland water, railway, coastal shipping and air respectively. Besides, user flag could have letters of "F", "Z", "W", "Y", "S" and "P" all of which except "F" are prepared for dummy link on five modes' layers. It is worth noting that "F" and "Z" indicate ferry and dummy link connected with centroid respectively.

Table 4.3
User Flag of Transport Network

	Link	Dummy Link
Road	R or F	Z
Inland Water	I or O	W
Rail	L	Y
Coastal Shipping	C or Q	S
Air	A	P

Speed used in dummy link, capacity used in dummy link and cost used in dummy link are used for giving speed, capacity and transport cost to dummy link.

Files including project list should be prepared as files of "*.lst", consisting of link names identical with projects proposed as follows.

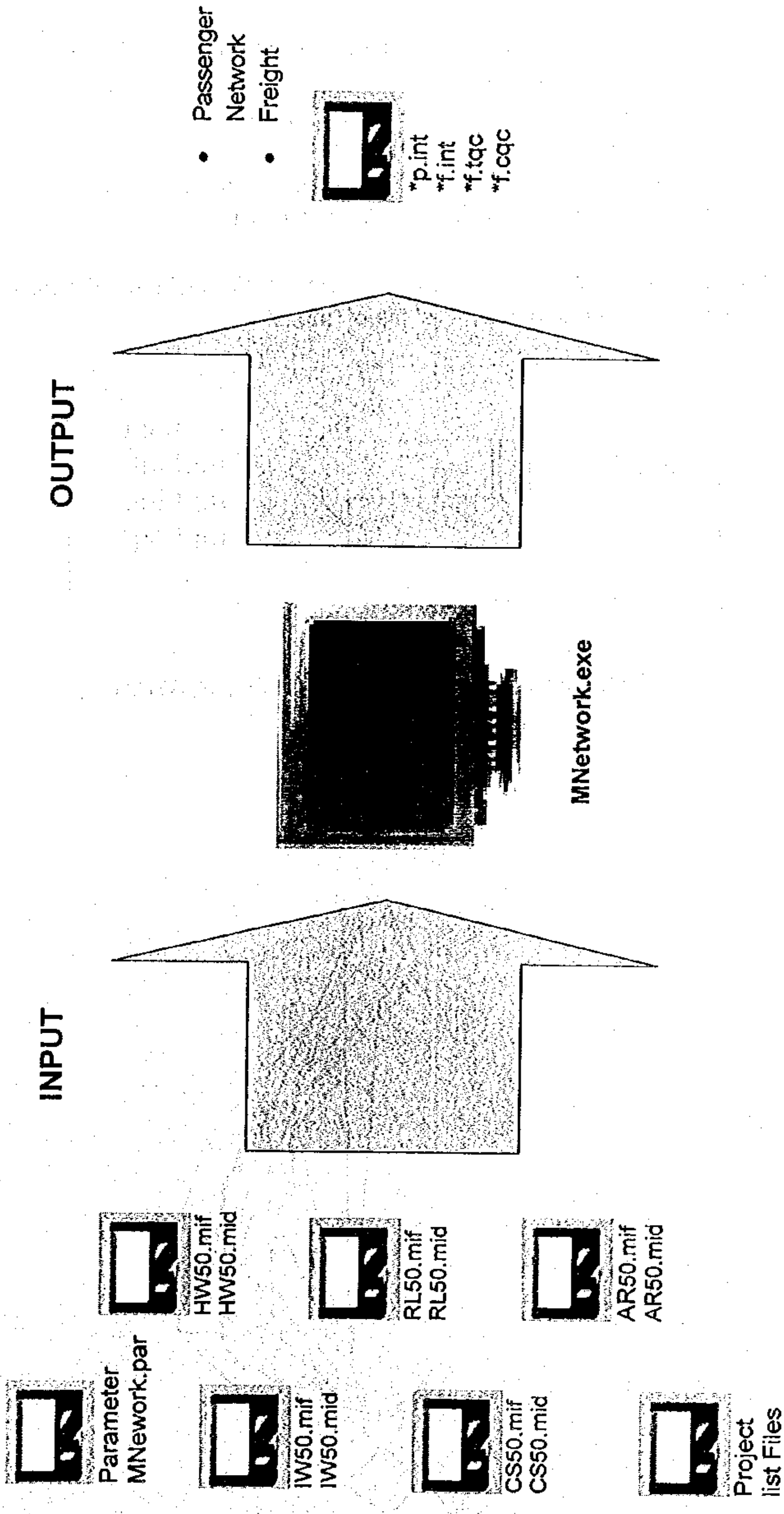
```
T1R1
TRC3
TRC7
TRC8
TRC11
T1R12
T1R10
T1R14
TRC6
TRC5
```

QC type selected can take a value of 1 to 3. If one select "1", all the links will have type of QC curve 1 and, if one select "2", all the links will have type of QC curve 2. Meanwhile, if one can select "3", only links recorded in a file of project list will have type of QC curve 1 and the rest type of QC curve 2. For this reason, one should select QC type according to one's purpose.

Modes' Layers

After reading parameter file, then it will find and read five modes' layers (see chapter 4.2 in detail). Based on information recorded in each mode's layer, it will calculate links' factors necessary for traffic assignment and generate cost-flow relationship.

Figure 4.4
Network Building Operation



Networks and QC curves

As a result of executing "MNetwork.exe", two assignment networks and two QC curves can be obtained and they are:

- *p.int: assignment network for passenger demand;
- *f.int: assignment network for freight demand;
- *f.tqc: QC curve used for traffic assignment of freight demand; and
- *f.cqc: QC curve used for calculating transport cost.

Note that * is the same as filename of project list. For instance, the following four files can be expected to a project list file of "mp.lst".

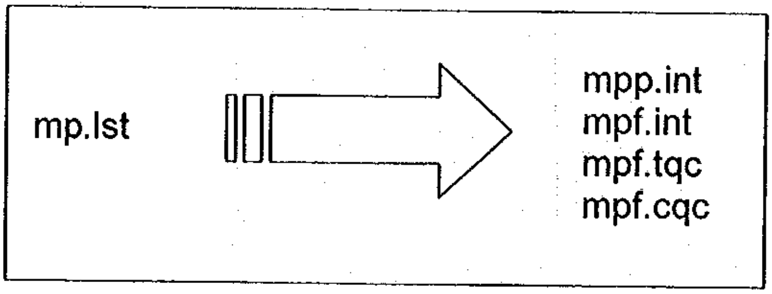
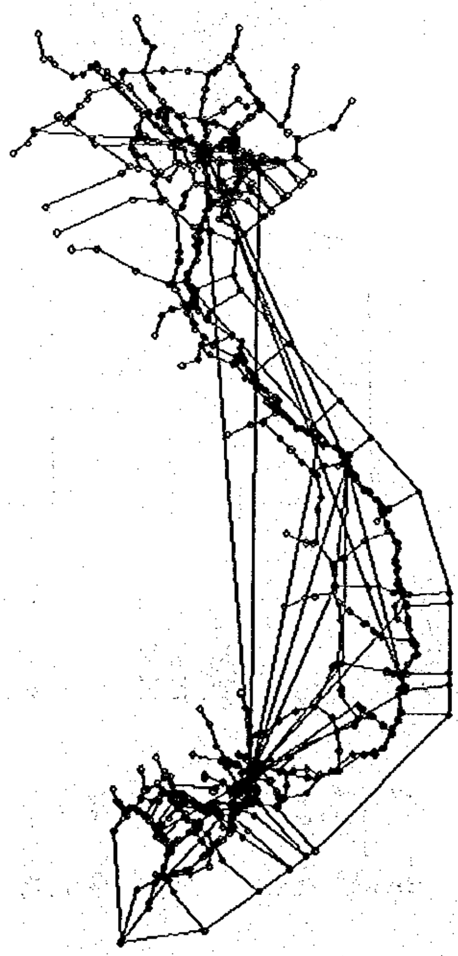


Figure 4.5
An Example of Assignment Network (JICA STRADA)



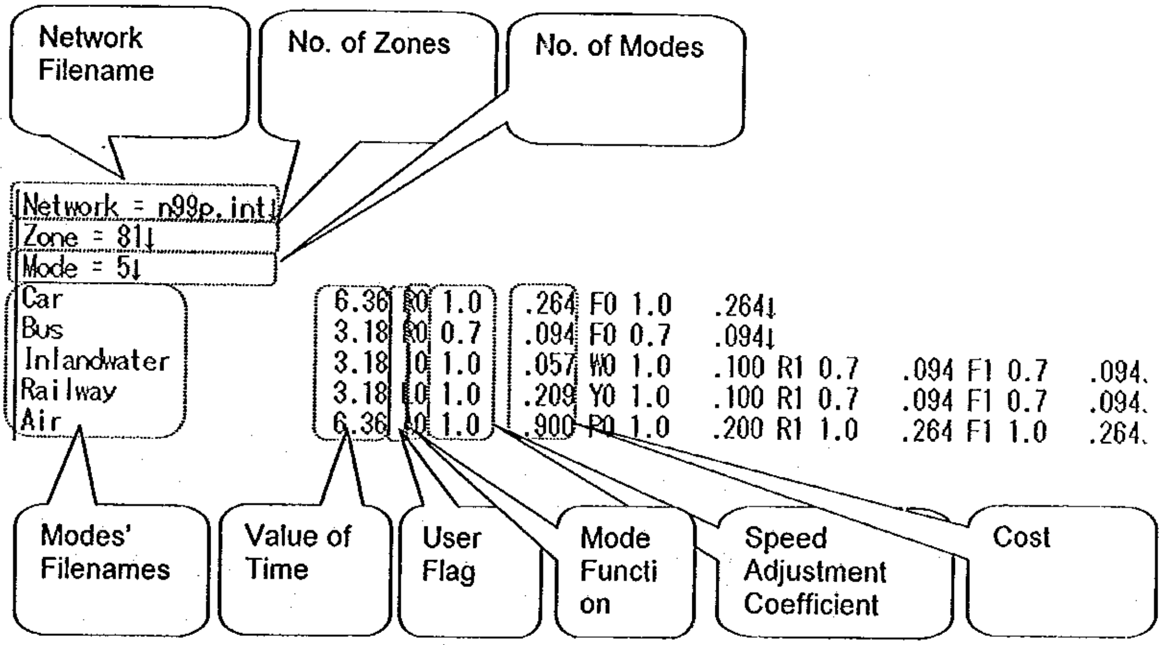
4.5 Inter-zonal Impedance

Inter-zonal impedances such as inter-zonal travel time, travel cost and travel distance are one of exogenous variables while doing demand forecast in terms of passenger transport. The assignment network created in the previous step makes it possible to get information on inter-zonal impedances including travel time, cost and distance through executing "MakDat01.exe" as illustrated in Figure 4.5.

- Reading parameter file;
- Calculating minimum route by mode over travel distance, travel time and travel cost; and
- Writing and saving inter-zonal impedances of travel distance, time and cost by mode.

Parameter File

Parameter file (MatDat01.dat) includes file names to be output and information necessary for calculating inter-zonal impedances.



Network filename is one used in calculating inter-zonal impedances.
No. of zones becomes 81 zones if no significant changes in assignment network.
No. of modes becomes 5 modes including car, bus, inland water, railway and air.

Modes' Filenames to be output have three kinds of extension files, i.e., *.dij, *.tij, and *.cij. These extension files mean travel distance (*.dij), time (*.tij) and cost (*.cij) between zones respectively. For instance, if one sets filename as "car", he or she can expect three files of "car.dij", "car.tij" and "car.cij" which are saved in JICA STRADA file format.

Value of Time is used for converting travel time taken into travel cost.

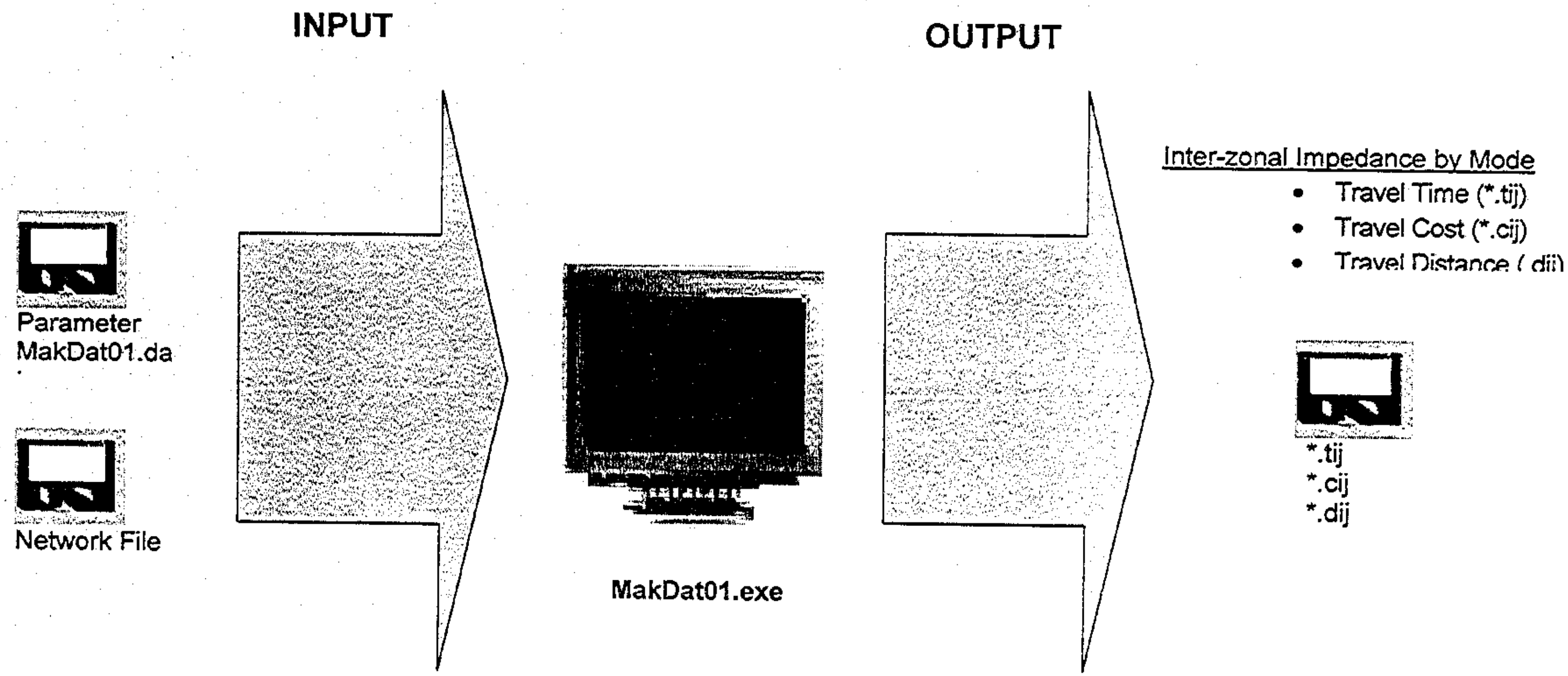
User flags are ones used for calculating inter-zonal impedance of a specific mode. Car and bus would have "R" and "F" as user flags, inland water "I", "W", "R" and "F", railway "L", "Y", "R" and "F" and air "A", "P", "R" and "F". Note that "R" and "F" should be absolutely used because road is functioned as access mode to port, railway station or airport.

Mode function is needed to judge whether a certain mode is used as a main mode or a access mode. If "0" is chosen, it implies that mode chosen is used as the main mode. But if "1" is chosen, it should be interpreted as the access mode. One can find that road is used as the access mode for all the modes.

Speed adjustment coefficient is to manage travel speed for a specific mode. For instance, a bus is slower than a car even though they run on the same link. For a link with travel speed 50km/h, a coefficient of 0.7 makes it 35km/h.

Cost in usual means operating cost or transfer cost.

Figure 4.5
Inter-zonal Impedance Creating Operation



5 FORMULATION OF PRESENT OD MATRIX

5.1 General

For a comprehensive analysis of the nationwide transport network, a set of reliable input data is necessary. The most critical and difficult one is transport demand, both for present and future. The first step is to know what is the current transport demand in terms of generation and distribution. For this, a series of traffic surveys have been conducted, and present origin-destination (OD) matrix of inter-provincial movement of passengers and goods by major commodity group has been worked out.

As shown in Figure 5.1, two approaches were adopted: traffic survey and usage of existing data. OD matrices of road and inland waterway were built from the former while those of railway, air transport and coastal shipping from the latter. With regard to the latter, railway station-to-station OD traffic was provided by VR and the OD matrix of the Master Plan Study of Coastal Shipping Rehabilitation and Development (JICA, 1997) was referred to and updated. Note, however, that the OD table of air transport was estimated from the number of flights and average load factor.

5.2 Road and Inland Waterway

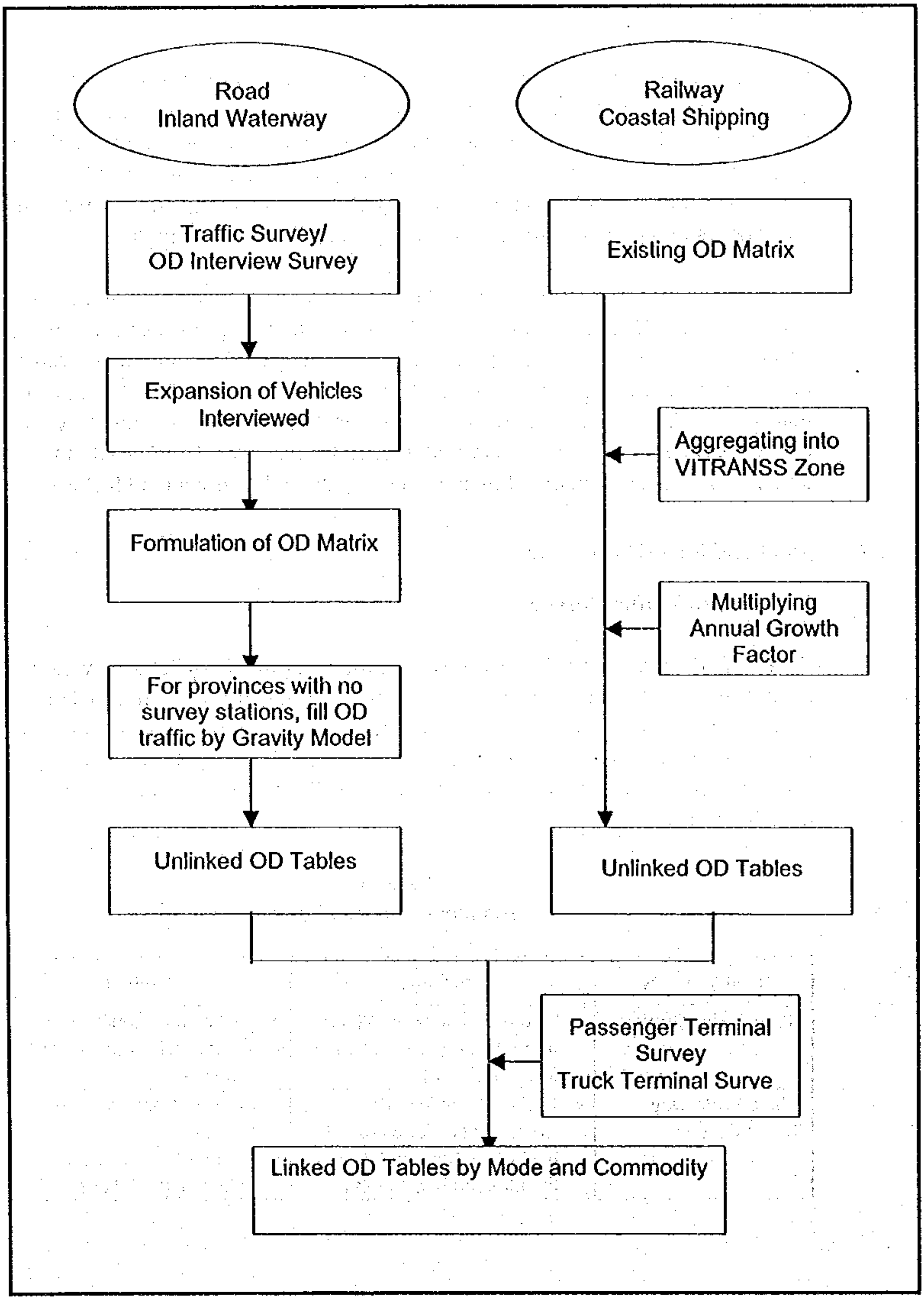
Summary of Traffic Survey:

With regard to road, traffic survey was carried out at 39 stations, covering north, central and south and including a three-day traffic count and 14-hour OD interview survey. On the other hand, the traffic survey of inland waterway was conducted at 20 stations of the Red River delta and 20 stations of the Mekong River delta, requiring a two-day traffic count at all stations and 14-hour OD interview at only 15 stations as depicted in Table 5.1.

Table 5.1
Summary of Traffic Survey

Traffic Survey	Coverage	Method
Road Traffic Survey	• 39 on-road stations (20 in north, 6 in central and 13 in south Vietnam)	• 3-day traffic count • 14-hour OD interview at roadside
Inland Waterway Traffic Survey	• 40 stations at inland waterway sections (20 in the Red River delta and 20 in the Mekong River delta)	• 2-day (24-hour or 14 hour) traffic count • 14-hour OD interview at selected 15 stations

Figure 5.1
General Procedure of Present OD Table Estimation



Note: OD table of air transport was estimated from the number of flights and average load factor.

Expansion of Vehicles & Formulation of OD Matrix

Vehicles surveyed at survey stations should be expanded as follows, taking into account daily traffic volume.

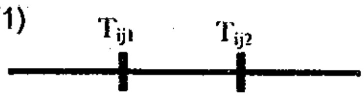
$$T_{ijk} = S_{ijk} / (SC_k / TC_k) \qquad (5.1)$$

Where:

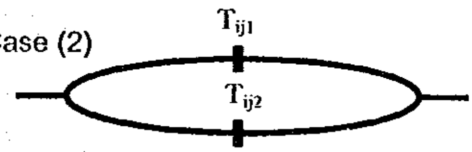
T_{ijk} = daily average traffic between origin *i* and destination *j* at survey station *k*
S_{ijk} = interviewed traffic between origin *i* and destination *j* at survey station *k*
TC_k = average daily traffic counted at survey station *k*
SC_k = sample size interviewed at survey station *k*

SCk/TCk means the sampling rate. The lower this rate, the higher the error made in estimating OD matrix. Rates lower than 5% may lead to unreliable estimates.
In order to fix OD traffic between OD pairs, it is required to infer it from OD traffic interviewed at all survey stations. Information on how many routes between OD pairs and how many survey stations on route is indispensable to investigate how survey stations are located on route, i.e., "in series" or "in parallel", because it has impact on determination of OD traffic. For example, suppose the following two cases: in series and in parallel.

Case (1)



Case (2)



In Case (1), OD traffic, Tij, becomes either the OD traffic at station 1, Tij1, or the OD traffic at station 2, Tij2. In Case (2), however, OD traffic, Tij, becomes the sum of Tij1 and Tij2. Note that average OD traffic of Tij1 and Tij2 was used in Case (1) because counted traffic of Tij1 and Tij2 is different even though they should be same theoretically.

One can obtain present OD matrix through above two steps: expansion of vehicles and formulation of OD matrix. Executing "aggregate.exe" makes it possible expand the number of vehicles and formulate OD matrix at all the survey stations. After obtaining it, one can expect present OD matrix through executing "odest.exe". Its operation is shown in Figure 9.2.

"Aggregate.exe", which is a component to make station OD matrix, needs two files as input data: expansion factor ("mfactor.data") and OD interview data ("tpv.dat"). The former is calculated by equation (5.1) taking into account traffic count survey and OD interview survey and it was saved as shown in the following.

Figure 5.2
Present OD Matrix Formulating Operation, Road and Inland Water

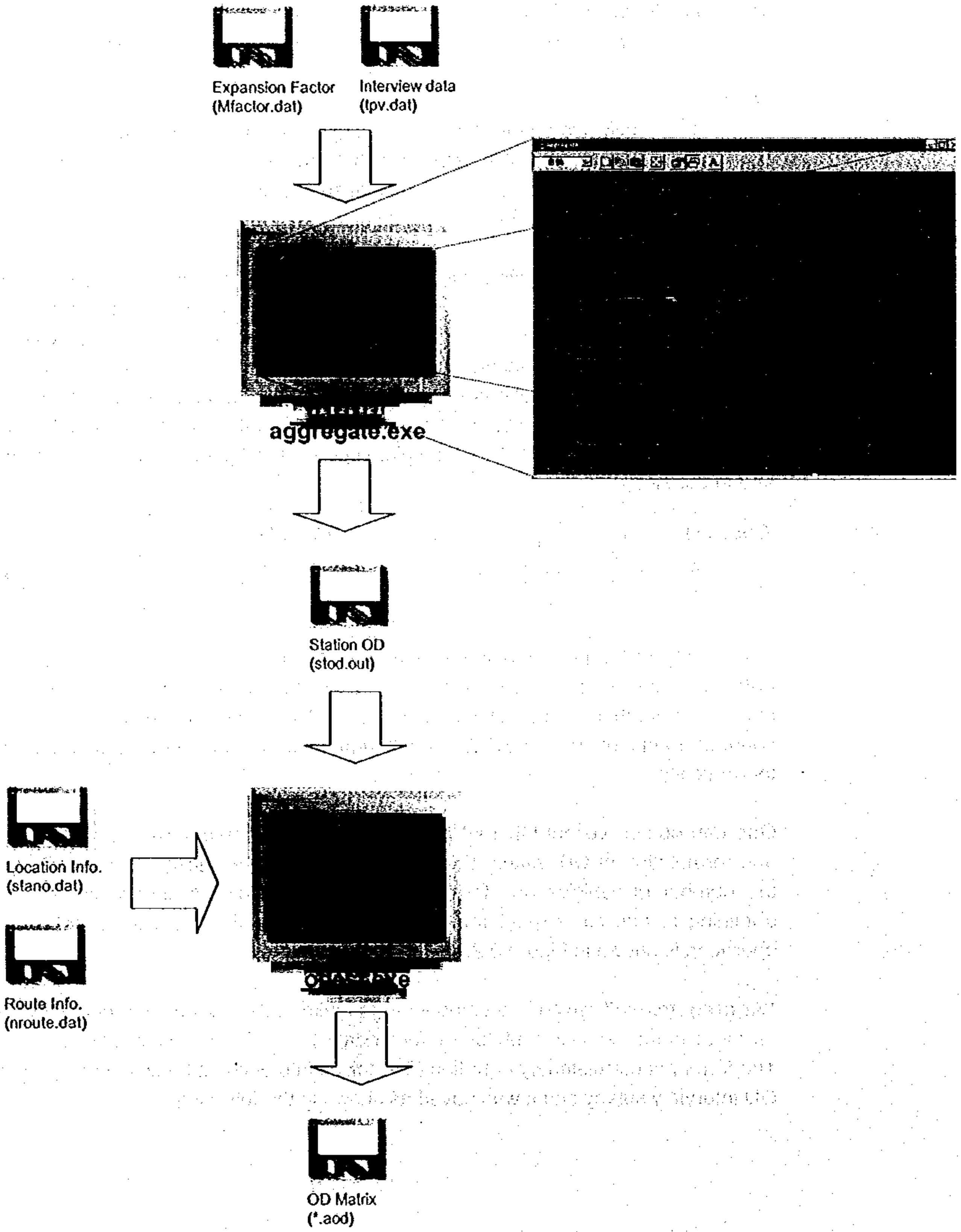


Figure 5.2
Present OD Matrix Formulating Operation, Road and Inland Water

Expansion Factor ("mfactor.dat")

```
1.68 1.50 1.46 1.52↓
1.54 1.31 1.55 1.48↓
1.38 1.10 1.31 1.23↓
9.44 6.39 6.84 7.16↓
1.36 1.43 1.69 1.51↓
10.84 5.81 4.24 5.34↓
7.24 3.25 4.36 4.42↓
3.34 1.63 2.25 2.16↓
3.89 2.78 4.01 3.55↓
1.25 1.00 1.46 1.27↓
1.85 1.38 1.95 1.73↓
10.15 2.62 2.73 3.30↓
```

Car | Bus | Truck | Total

Meanwhile, the latter comes from OD interview survey as follows.

OD Interview Data ("tpv.dat")

```
1QL6   26 3  99 6.00 1 1 45 2 32401 10901  5  4  3 1 1
1QL6   26 3  99 6.15 1 1 45 2 32401 32301  5  4  3 1 1
1QL6   26 3  99 6.50 1 3 19 2 32401 10501 56 45 43 1 2
1QL6   26 3  99 6.35 1 3 19 2 32405 10105 56 30 28 1 2
1QL6   26 3  99 6.30 1 3 18 1 32401 10105 24 20 18 1 1
1QL6   26 3  99 7.00 1 1 45 2 32401 32501  5  4  3 1 1
```

Data Form of "tpv.dat"

No.	Item	Length	Column
1	Station No.	3	1-3
2	Road No.	7	4-10
3	Date	3	11-13
4	Month	3	14-16
5	Year	5	17-21
6	Time	6	22-27
7	Direction	2	28-29
8	Vehicle Type	2	30-31
9	Vehicle Model	3	32-34
10	Vehicle Owner	2	35-36
11	Origin Code	6	37-42
12	Destination Code	6	43-48
13	No. of Seat	4	49-52
14	No. of Passengers(including driver)	4	53-56
15	No. of Passengers(excluding driver)	4	57-60
16	No. of Trips	3	61-63
17	Per day	3	64-66
18	Total weight of truck	5	67-71
19	Total weight of cargo carried	5	72-76
20	Type of cargo carried	3	77-79
21	Weight of cargo carried	7	80-86
22	Type of cargo carried	3	87-89
23	Weight of cargo carried	7	90-96
24	Type of cargo carried	3	97-99
25	Weight of cargo carried	7	100-106
26	Type of cargo carried	3	107-109
27	Weight of cargo carried	7	110-116
28	Type of Transport	2	117-118
29	Type of Loading	2	119-120

Only if one executes "aggregate.exe", one can find the following message on the screen.

```
                    List of OD Matrix
OD Matrix of Car                         : 1
OD Matrix of Bus                         : 2
OD Matrix of Truck                       : 3
OD Matrix of Commodity 1                 : 101
OD Matrix of Commodity 2                 : 102
OD Matrix of Commodity 3                 : 103
OD Matrix of Commodity 4                 : 104
OD Matrix of Commodity 5                 : 105
OD Matrix of Commodity 6                 : 106
OD Matrix of Commodity 7                 : 107
OD Matrix of Commodity 8                 : 108
OD Matrix of Commodity 9                 : 109
OD Matrix of Commodity 10                : 110
OD Matrix of Commodity 11                : 111
OD Matrix of Commodity 12                : 112
OD Matrix of Commodity 13                : 113
OD Matrix of Sugarcane                   : 1021
OD Matrix of Sugar                       : 1022
OD Matrix of Cement                      : 1061
OD Matrix of Cement Others               : 1062

What kind of OD matrix do you want? Select No.? ⇒
```

One should select mode or commodity item OD matrix of which one wants to formulate and press enter key. Then it will make OD matrix at all survey stations in the filename of "stod.out" which becomes one of input files while executing "odest.exe".

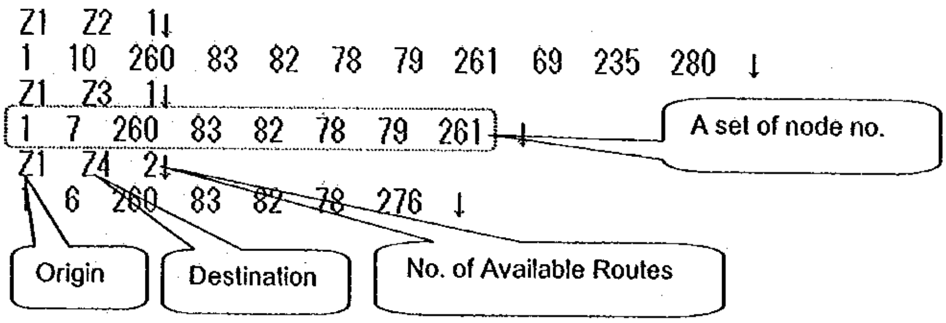
"Odest.exe" requires three files as input files: station OD matrix ("stod.out"), survey location information ("stano.dat") and route information ("nroute.dat"). The survey location information helps to identify location of survey station on the network and was recorded as follows.

Survey Location Information ("stano.dat")

OD interview station No.	Direction Code	A Node No.	B Node No.
1	1	268	28↓
1	2	28	268↓
2	1	222	47↓
2	2	47	222↓
3	1	257	265↓
3	2	265	257↓

Meanwhile, route information helps to identify available routes between origin and destination and was recorded as follows.

Route Information ("nroute.dat")



As a result of execution of "aggregate.exe" and "odest.exe", one can obtain OD matrix by mode or by commodity item. The following are output filenames according to mode or commodity number selected in executing "aggregate.exe".

Output Filenames according to the Number Selected

Mode or Commodity Item Number Selected		Output Filename
OD Matrix of Car	:1	"carod.aod"
OD Matrix of Bus	:2	"busod.aod"
OD Matrix of Truck	:3	"truckod.aod"
OD Matrix of Commodity 1	:101	"item1od.aod"
OD Matrix of Commodity 2	:102	"item2od.aod"
OD Matrix of Commodity 3	:103	"item3od.aod"
OD Matrix of Commodity 4	:104	"item4od.aod"
OD Matrix of Commodity 5	:105	"item5od.aod"
OD Matrix of Commodity 6	:106	"item6od.aod"
OD Matrix of Commodity 7	:107	"item7od.aod"
OD Matrix of Commodity 8	:108	"item8od.aod"
OD Matrix of Commodity 9	:109	"item9od.aod"
OD Matrix of Commodity 10	:110	"item10od.aod"
OD Matrix of Commodity 11	:111	"item11od.aod"
OD Matrix of Commodity 12	:112	"item12od.aod"
OD Matrix of Commodity 13	:113	"item13od.aod"
OD Matrix of Sugarcane	:1021	"item14od.aod"
OD Matrix of Sugar	:1022	"item15od.aod"
OD Matrix of Cement	:1061	"item16od.aod"
OD Matrix of Cement Others	:1062	"item17od.aod"

Note: When one wants to obtain OD matrix of inland water, one should use "river.dat" and "route.dat" instead of "tpv.dat" and "nroute.dat". A file of "river.dat" has the following data form.

Data Form of "river.dat"

No.	Item	Length	Column
1	Station No.	3	1-3
2	Date	3	4-6
3	Month	3	7-9
4	Year	5	10-14
5	Time	6	15-20
6	River Name	7	21-27
7	Direction	2	28-29
8	Vessel Type	2	30-31
9	Vessel Owner	2	32-33
10	Origin Code	6	34-39
11	Destination Code	6	40-45
12	No. of Seat	4	46-49
13	No. of Passenger	3	50-52
14	No. of Crew	3	53-55
15	No. of Trip	4	56-59
16	Per day	4	60-63
17	Capacity registered (Vessel)	6	64-69
18	Dimension of Vessel (Length)	6	70-75
19	Dimension of Vessel (Width)	6	76-81
20	Dimension of Vessel (Depth registered)	6	82-87
21	Capacity of Pushing Vessel	6	88-93
22	Capacity of Towing Vessel	6	94-99
23	No. of barge	6	100-105
24	Capacity registered (barge)	6	106-111
25	Dimension of Barge (Length)	6	112-117
26	Dimension of Barge (Width)	6	118-123
27	Dimension of Barge (Depth registered)	6	124-129
28	Type of cargo carried	3	130-132
29	Weight of cargo carried	7	133-139
30	Type of cargo carried	3	140-142
31	Weight of cargo carried	7	143-149
32	Type of cargo carried	3	150-152
33	Weight of cargo carried	7	153-159
34	Type of cargo carried	3	160-162
35	Weight of cargo carried	7	163-169

Use of OD matrix of the Central Region

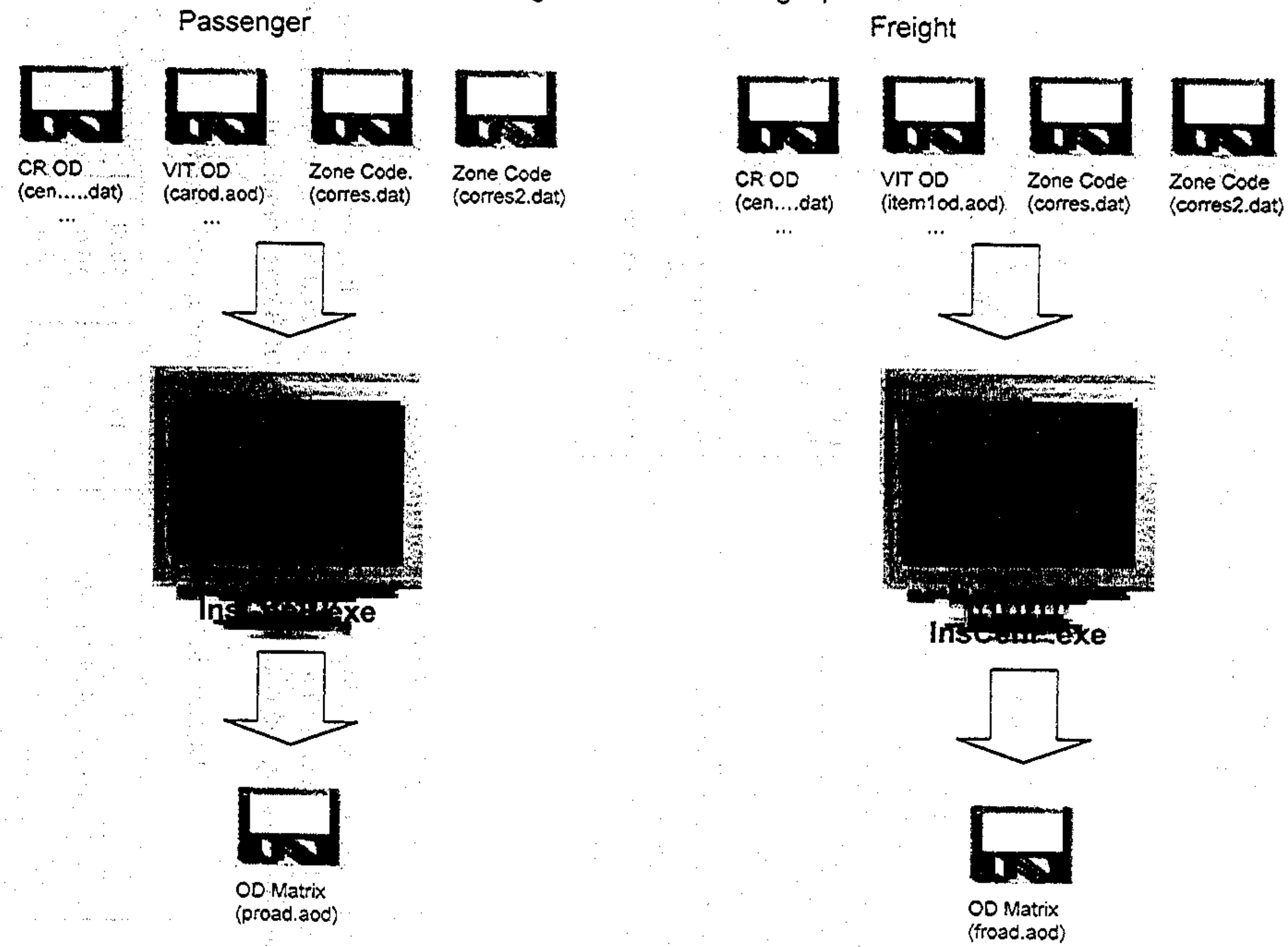
In VITRANSS, only six on-road survey stations were taken from the central region because it was assumed to utilize the results of the "Transport Master Plan for the Central Region of Vietnam (1998)". Taking into account the growth rate, the OD matrix of the "Transport Master Plan for the Central Region of Vietnam" was applied to the VITRANSS. Note, however, that this process is limited to road transport.

OD matrix is updated through the following steps.

i) Reading OD matrix used in the Central Region study.
ii) Reading OD matrix made in the VITRANSS study.
iii) Reading zone codes of the Central Region study and the VITRANSS study
iv) Inserting OD traffic investigated in the Central Region study into OD matrix of the VITRANSS study.

As shown in Figure 5.3, executive files of "InsCenP.exe" and "InsCenF.exe" make it possible make use of OD matrix of the Central Region study and add it to that of the VITRANSS study. In basic, the two executive files require four input files: Central Region OD matrix ("cen_good1_od.dat" ...... "cen_good9_od.dat"), VITRANSS OD matrix ("item1od.aod" ...... "item17od.aod"), zone code data for aggregating ("corres.dat") and zone code data for comparing zone codes of between the Central Region study and the VITRANSS (corres2.dat).

Figure 5.3
Central Region OD Matrix Using Operation



5.3 Railway

Adjustment of Commodity Items:

Station-to-station freight traffic is composed of 16 commodity items shown in Table 5.2 and they are not identical with the commodity classification of VITRANSS. So, it was required to adjust the classification of VR into that of VITRANSS.

Table 5.2
Adjustment of Commodity Items

VR	VITRANSS
1. Agriculture products	1.Rice and other food crops
2. Forest products	2.Wood and forest products
3. Metal wares	3.Steel
4. Stone and sands 5. Brick and tile	4.Construction materials
6. Cement	5.Cement
7. Appetite 8. Fertilizer	6.Fertilizer
9. Coal	7.Coal
10. Petroleum products	8.Petroleum products
11. Foodstuff	9.Industrial products
12. Chemicals 13. Cotton and textile 14. General cargo 15. Others	10.Manufacturing products
16. Food	11.Animal meat and others

Increase in Passenger and Freight Volume:

In order to formulate the 1999 OD matrix of railway, it is necessary to take into account the growth rate in terms of both passenger and freight volume. Based on the growth rates, the railway OD matrix of VITRANSS was completed.

Table 5.3
Change in Railway Passenger Volume, 1997-1998

Million

	1997	1998	1998/1997
Including Intraprovincial Traffic	9.3	10.0	1.08
Excluding Intraprovincial Traffic	7.6	8.3	1.09

Source: VR

Table 5.4
Change in Railway Freight Volume, 1997-1998

Tons 000

	1997	1998	1998/1997
1. Coal	894	974	1.09
2. Petroleum products	90	77	0.86
3. Appetite	1,140	1,209	1.06
4. Metal wares	257	309	1.20
5. Chemical	124	127	1.02
6. Fertilizer	456	604	1.32
7. Cement	616	413	0.67
8. Stone and sand	563	639	1.13
9. Brick and tile	26	15	0.58
10. Forest products	125	93	0.74
11. Agriculture products	70	42	0.60
12. Food	43	92	2.14
13. Foodstuff	235	197	0.84
14. Cotton and textile	9	5	0.56
15. General Products	72	67	0.93
16. Others	34	20	0.59
Total	4,764	4,883	1.02

Source: VR

OD Matrix Formulating Operation

OD matrix of rail is made through the following steps.

v) Reading station-to station OD in terms of both passenger and freight.
vi) Reading station code and VITRANSS zone code.
vii) Aggregating into VITRANSS zone code.

As shown in Figure 5.4, executive files of ***"MRailPOD.exe"*** and ***"MRailFOD.exe"*** make it possible create rail OD matrices of passenger and freight. In basic, the two executive files require zone code ("code.dat") and station OD ("pax98.dat" as for passenger and "goods98.dat" as for freight).

Zone code includes information on station code and VITRANSS zone code and was recorded as follows.

Zone Code ("code.dat")

```
1001  1↓
1002  1↓
1003  1↓
1004  9↓
1005  9↓
```

Station code

VITRANSS zone code

Whereas station OD includes origin, destination and freight amount carried and was recorded as follows.

Station OD ("pax98.dat" or "goods98.dat")

```
1001    1001       71↓
1001    1002       17↓
1001    1009     7690↓
1001    1010     3839↓
1001    1011     1229↓
1001    1013    76505↓
1001    1015     2443↓
1001    1017     6959↓
```

Origin Station Code

Destination Station Code

Freight Amount Carried

5.4 Other Modes

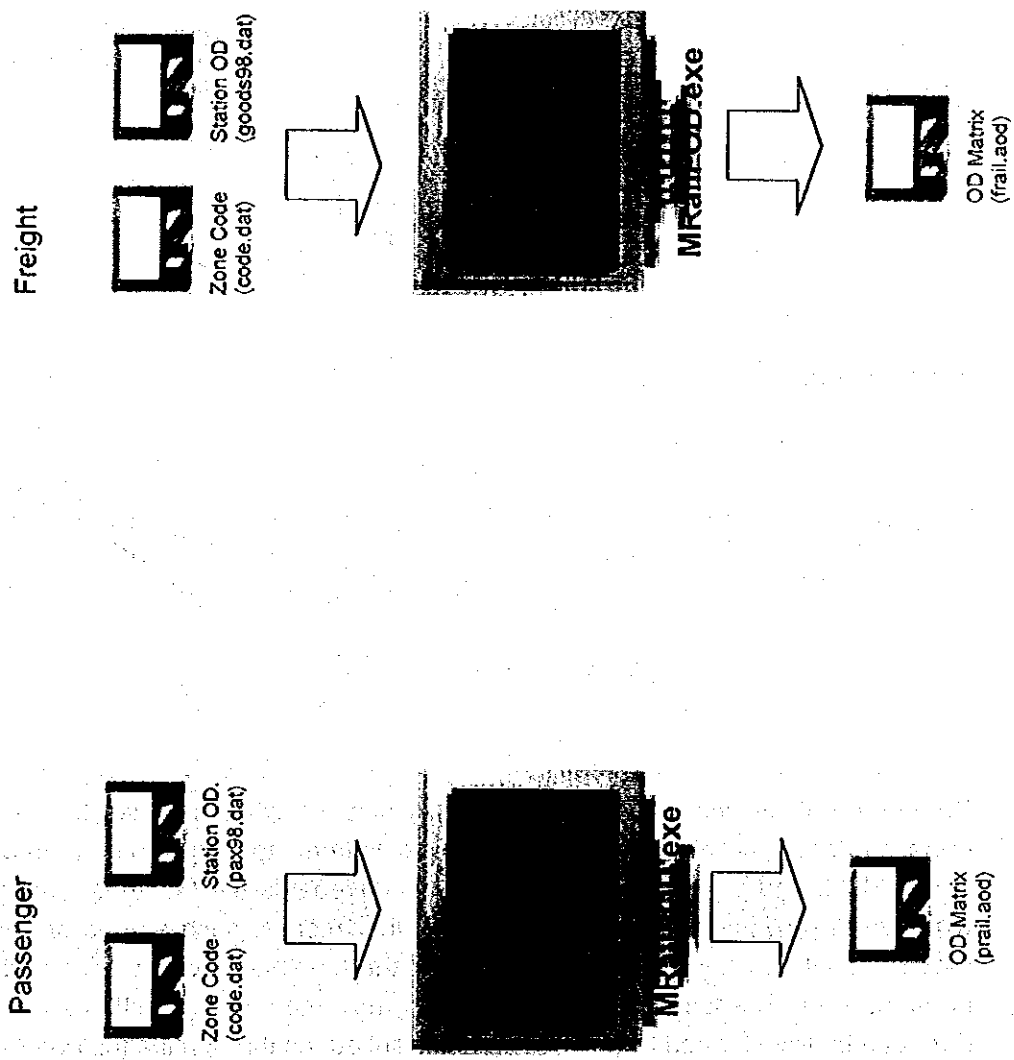
The OD matrix of coastal shipping was estimated from that of the Master Plan Study on Coastal Shipping Rehabilitation and Development (JICA, 1997), taking into account the VITRANSS zoning system and the growth rate of freight volume. Passenger transport was disregarded because its amount is small.

Table 5.5
Adjustment of Commodity Items

Master Plan Study on Coastal Shipping Rehabilitation and Development	VITRANSS
1. Agricultural products	1. Agricultural products
2. Construction materials and mining products	2. Construction materials 3. Coal
3. Oil	4. Petroleum products
4. Bulky Cargo	5. Wood and forestry products 6. Steel 7. Fertilizer
5. Cement	8. Cement
6. Other cargo	9. Industrial crops 10.Manufacturing goods

Meanwhile, the OD table of air transport was estimated from the number of flights and average load factor. Freight volume carried by air transport is very small and was regarded as manufacturing goods.

Figure 5.4
OD Matrix Formulating Operation

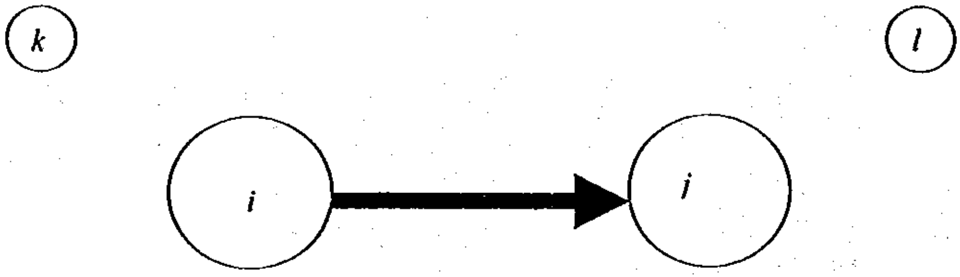


5.5 Adjustment from Unlinked Trip to Linked Trip

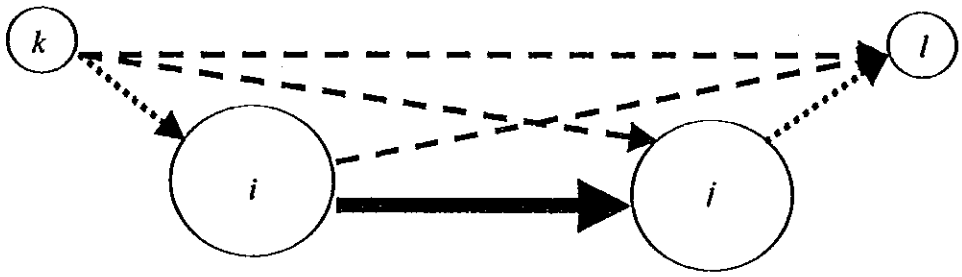
Basic Concept:

As mentioned earlier, passenger and truck terminal survey data are a clue to be able to change from unlinked to linked trip. Following is a simple example to help understand the basic concept of transforming unlinked into linked trip:

(Unlinked Trip)



(Linked Trip)



Suppose that province i and j have railway stations while province k and l have none. Under the unlinked trip, there is traffic only from i to j, Tij, and none between k and i, Tki, k and j, Tkj and k and l, Tkl. This disregards the fact that some people who live in province k go to province i by other modes, such as bus or car, then move to final destination to province j or l. If the terminal survey was carried out in province i and passenger behavior or cargo movement was exactly captured, the data can be transformed from unlinked trip to linked trip through the following steps:

- Calculate probability of movement between provinces, P_{ij}, P_{kj}, P_{il}, and P_{kl} from the terminal survey.
- Calculate linked traffic between provinces as follows:

$$Tl_{ij}=Tu_{ij}*P_{ij}$$
$$Tlkj=Tuij*Pkj$$
$$TLkl=Tuij*Pkl$$
$$Tlil=Tuij*Pil$$

Where: Tl_{ij} = Traffic from I to j in linked trip
Tu_{ij} = Traffic from I to j in unlinked trip

- Adjust OD matrix of access or egress modes such as car, bus and so on. Note that motorcycle and bicycle were disregarded.

$$Tl_{kim}=Tu_{kim}-Tu_{ij}*(P_{kim})$$
$$TL_{jlm}=Tu_{jlm}-Tu_{ij}*(P_{jlm})$$

Where:
Tl_{kim} = Linked traffic from k to i by access mode m
TL_{jlm}=Linked traffic from j to l by egress mode m
Tu_{kim}=Unlinked traffic from k to i by access mode m
Tu_{jlm}=Unlinked traffic from j to l by egress mode m
P_{kim}=Probability of movement from k to i by access mode m
$Pjlm$=Probability of movement from j to l by egress mode m

Linked Trip Making Operation

Executive files of "***ToLinkP.exe***" and "***ToLinkF.exe***" allow ones to change unlinked trip into linked trip in terms of passenger and freight respectively, as shown in Figure 5.5. The two executive files require four files as input files: parameter file ("tolinkp.par" for passenger or "tolinkf.par" as for freight), zone code ("cores.dat" for passenger or "fcores.dat" for freight), unlinked OD ("*.aod") and terminal OD interview data ("terminalp.dat" for passenger or "terminalf.dat" for freight).

Parameter file includes information on filename(s) of unlinked OD and filename(s) to be output and was recorded as follows.

Parameter File for Passenger ("tolinkp.par")

```
pass.aod↓
pass9_99.aod←
```

Filename of unlinked OD

Filename to be output

Parameter File of Freight ("tolinkf.par")

```
rf6_17.aod↓
if6_17.aod↓
raf6_17.aod↓
cf6_17.aod↓
af6_17.aod↓
r9_99.aod↓
i9_99.aod↓
r9_99.aod↓
c9_99.aod↓
a9_99.aod↓
```

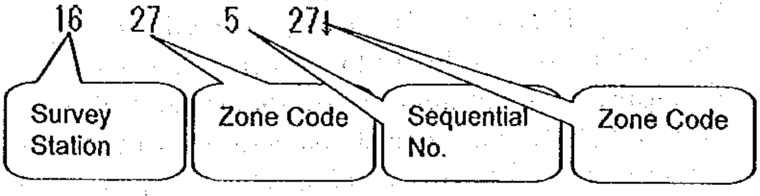
Filenames of unlinked OD

Filename to be output

Zone code file includes information on correspondence between survey station and province.

Zone Code ("cores.dat" or "fcores.dat")

```
11   1   1   1↓
12   1   1   1↓
13   2   2   2↓
14  17   3  17↓
15  16   4  16↓
16  27   5  27↓
```



Terminal OD interview files come from interview survey at major interchange spots such as bus terminal, railway station, airport and port and its form is as follows.

Data Form of "terminalp.dat"

No.	Item	Length	Column
1	Sex	4	1-4
2	Age	4	5-8
3	Occupation	4	9-12
4	Residence	6	13-18
5	Work/school place	6	19-24
6	Car ownership	4	25-28
7	Origin	6	29-34
8	Final destination	6	35-40
9	Trip purpose	4	41-44
10	From(origin)	6	45-50
11	To	6	51-56
12	Transport Mode	4	57-60
13	To	6	61-66
14	Transport Mode	4	67-70
15	To	6	71-76
16	Transport Mode	4	77-80
17	To	6	81-86
18	Transport Mode	4	87-90
19	To	6	91-96
20	Transport Mode	4	97-100
21	To	6	101-106
22	Transport Mode	4	107-110
23	To	6	111-116
24	Transport Mode	4	117-120
25	Time for walking and buying ticket	4	121-124
26	Time for waiting	4	125-128
27	Chosen reason 1	4	129-132
28	Chosen reason 2	4	133-136
29	Problem 1	4	137-140
30	Problem 2	4	141-144
31	Service availability	4	145-148
32	Frequency	4	149-152
33	Comfort	4	153-156
34	Safety	4	157-160
35	Punctuality	4	161-164
36	WTP for 30 min. reduction	6	165-170
37	WTP for 20 min. reduction	6	171-176
38	WTP for 10 min reduction	6	177-182
39	WTP for 5 min reduction	6	183-188
40	Station No.	4	189-192

Data Form of "terminalf.dat"

No.	Item	Length	Column
1	Vehicle Type	4	1-4
2	Vehicle Model	4	5-8
3	Vehicle Owner	4	9-12
4	Cooperative	4	13-16
5	Origin	6	17-22
6	Destination	6	23-28
7	Total weight of truck	6	29-34
8	Total weight of cargo carried	6	35-40
9	Types of cargo carried	4	41-44
10	Weight of cargo carried	6	45-50
11	Types of cargo carried	4	51-54
12	Weight of cargo carried	6	55-60
13	Types of cargo carried	4	61-64
14	Weight of cargo carried	6	65-70
15	Types of cargo carried	4	71-74
16	Weight of cargo carried	6	75-80
17	Type of transport	4	81-84
18	Standard of road	4	85-88
19	Condition of road	4	89-92
20	Traffic condition/congestion	4	93-96
21	Loading facilities/services	4	97-100
22	Bus station/freight terminal charges	4	101-104
23	Parking facilities	4	105-108
24	Tolls and other charges	4	109-112
25	Competition from other transporters	4	113-116
26	Police enforcement measures	4	117-120
27	Others	4	121-124
28	Station No.	4	125-128

Figure 5.5
Linked Trip Making Operation